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PREFACE

It is gratifying that in spite of the inevitable dislocation caused by the war, it is possible to publish a volume of Progress Reports from Experiment Stations in nearly all the countries from which Reports have usually been received in the past. The Anglo-Egyptian Sudan is in fact the only country from which no report is available, and this is due to the fact that the Director of Agriculture was of opinion that the information concerning cotton that would be contained in it might be helpful to the enemy, and that publication should consequently be withheld. The records are, however, being preserved so that continuity will be maintained when publication of them is again approved.

The Corporation's work in Northern Rhodesia has been discontinued. It had established the fact that cotton was unlikely to become an exportable commodity in any commercial quantity in the near future and it was decided that the officer in charge could be more usefully employed in the present emergency in assisting in the development of cotton and of food crops in Tanganyika Territory.

The three members of the staff stationed at the Experiment Station, Gatooma, Southern Rhodesia, have also been transferred to Tanganyika and their work there is described in the Progress Reports from the Experiment Stations of which they have been placed in charge.

The work at Gatooma, though necessarily considerably reduced, has not been discontinued, as will be seen from Major Cameron's report contained in the present volume, describing the numerous pieces of experimental work he was able to carry out.

Nearly all the members of the Station at Barberton, South Africa, asked for permission to volunteer for service with the South African forces. The requests from Colonial Governments for the Corporation's assistance by means of the loan of staff to supplement their Agricultural Departments had by that time been met and their services were not needed in a similar capacity by the Union Government. The Corporation accordingly felt that, since cotton was not an important crop in the Union, the greater part of the experimental work at Barberton could justifiably be suspended. All members of the Insect Pest Control section have gone on military service, and only Mr. Parnell and one other plant breeder now remain. Most of the Station has been

put on a maintenance basis, but as much breeding work is being carried on as the small staff remaining can handle. The stocks of selected seed have been safely stored.

The sub-station at Magut, Natal, has been closed, and the officer formerly in charge of it has gone on military service.

The seriousness of the damage to the Nyasaland cotton crop caused by insect pests, particularly red bollworm and stainers, has called for intensive work on the part of the two entomologists on the Corporation's staff in the Protectorate. Much important information has been collected and the work is being prosecuted vigorously in the hope of evolving some measure of control. If this proves possible, the full co-operation of the cultivators will also be necessary, however, in order to carry into effect whatever action may be considered advisable.

QUEENSLAND

COTTON RESEARCH STATION, BILOELA.
PROGRESS REPORT FOR THE SEASON 1939-40.

BY

W. G. WELLS.

Introduction.

The following progress report of the investigations conducted at the Cotton Research Station has been prepared from the reports submitted by Mr. W. A. R. Cowdry, Instructor in Cotton Culture, who recorded most of the technical observations connected with the experiments, and by Mr. S. Marriott, Assistant Research Officer, who was responsible for the operations connected with cotton breeding and genetics. The appended entomological notes have been compiled from reports submitted by Mr. D. J. Lee, Assistant Research Officer, stationed at Biloela.

Climatic.

Climatic conditions for the season under review were most unfavourable and had a deleterious effect upon the crop generally, causing very unsatisfactory yields in most of the experiments.

Following a dry and an exceptionally frosty winter, the spring months continued so dry that practically no planting was accomplished until late in November. December produced just over five inches of rain in three separate groups, originating from thunderstorms. There was only one useful fall of rain in January ; this measured 0·70 inches most of which was of a torrential nature causing severe run off of the storm waters. To augment the disastrous effect of the lack of January rains, a record heat wave was experienced in that month which continued unabated for twenty days with an average shade maximum temperature of 100·6°F. Copious rains were received early in February, but after this period temperatures again rose to heat wave conditions. During March a total precipitation of 7·07 inches occurred, but the three succeeding months were dry, only light rains falling.

The early growth of cotton at the Research Station was more vigorous and vegetative than usual, due to the combination of late planting and the forcing conditions of December. During the excessively hot weather of January, serious shedding of squares occurred, particularly on those areas where the nature of the soil prevented proper penetration of the December rains. Attacks by the corn-ear worm and the rough bollworm also caused loss of crop. On these de-cropped

plants the rains of early February promoted most rapid growth ; they became very elongated and bore only a few fruiting branches. This condition was somewhat checked later in the month by hot dry conditions which caused severe shedding that left many of the plants on the older cultivations nearly cropless. This was aggravated by a persistent attack of looper and some corn-ear worm. The remarkably heavy rain group of March caused effective leaching of the nitrates which resulted in a prolific crop of squares being formed that eventually produced the picking which was harvested in June in some of the experiments. The main picking commenced in May under very good weather conditions, thereby allowing of cotton of high grade being harvested.

Genetics and Breeding.

The programme for the production of a jassid-resistant cotton, as outlined in the last Annual Report, has proceeded with promising results.

The plots of progenies from resistant Miller plants selected last year, and the second generation hybrids between Miller and U.4, which were planted in isolated areas in the portions of the district which are usually jassid-infested, experienced good growing conditions, but unfortunately jassid attack was not severe until late in the season. Three Miller progenies showed very satisfactory uniformity of resistance and plant type and have been bulked separately for further increase and testing. Many re-selections from these and other strains were obtained, together with new resistant selections from jassid-infested crops.

Plants selected in the New Boykin variety during last season, which were apparently jassid-resistant, showed no signs of resistance in the current season. Crosses have, therefore, been made between U.4 and this variety, with a view to evolving a jassid-resistant cotton suitable for the fertile alluvial soils where the Miller variety makes excessive growth in wet seasons.

Jassid resistance seems to be inherited as an almost complete dominant in the first generation hybrids between Miller and U.4, and a study of the back-cross and the second and third generation hybrids which will be sown in jassid-infested areas during the coming season, may throw further light on the inheritance of this and other characters. The second generation hybrids showed some nice plant types combining the better characters of each parent, and the selection and fixing of such types from these hybrids and the back crosses will continue.

Selection work in the main Miller variety breeding block at the Research Station was continued, but owing to the very adverse season individual plant examination was made almost impossible on account

of the scarcity of crop. Some single-plant selections were made and a quantity of bulk progeny increases was retained for further study next year.

Miller Strain Test.—Five strains of the Miller variety were tested in a 5×6 randomised block experiment. The strains included Lot 38, 41, 41S, 42 and 45, the last mentioned being an addition to last year's experiment. Flowering was altogether low in comparison with other areas on the Station. No significant differences were found in either the total flowering for the first four weeks of counting, or for the seasonal totals, although it was thought permissible to state that Miller 41S showed a tendency to quicker and better flowering. No yields were obtained.

Experiments.

Varietal Tests.—A comprehensive test of the more recently introduced varieties of cotton was planted as a 12×6 randomised block experiment. A quick and very good germination was secured and the plants grew rapidly. By the end of December there was no discernible difference between varieties in structural characters. Flowering was extremely poor throughout the season and, as would naturally be expected under the adverse circumstances, the data obtained were very erratic and inconclusive. The Rowden and Indio-Acala varieties showed a possible tendency to earlier flowering than the rest, but no significant differences were obtained in the comparison of the total number of flowers produced for the season. Practically no bolls were matured, and therefore no comparisons could be made regarding yielding capabilities.

Varietal Test on Different Ages of Cultivation.—This investigation was designed to study the reaction of six varieties covering a representative range of the types of cotton grown in Queensland, to the following ages of cultivation :—

J. 5– 6. First year cotton following three years Rhodes grass.
J. 7– 8. Fifteen years of successive cropping of cotton following virgin grassland.
J. 9–10. First year cotton following three years Rhodes grass.
J.11–12. Eleventh year of successive cropping of cotton following virgin grassland.
J.13–14. Eight years of successive cropping of cotton following virgin grassland.
J.15–17. Second year of cotton following virgin grassland.

The varieties were—Oklahoma Triumph, a very early maturing $\frac{15}{16}$″ type ; Half and Half, a slightly slower maturing $\frac{7}{8}$″ to $\frac{15}{16}$″ type ;

New Boykin, a medium early maturing $\frac{15}{16}''$ type; Miller, a medium maturing 1″ type; Acala 16–7, a medium maturing $1\frac{1}{16}''$ type, and Indio-Acala, a medium to long season $1\frac{1}{8}''$ type. The varieties were arranged in a 6×6 Latin square on each age of cultivation.

These experiments were planted in late November and early December, the stands in all but the fifteen-year-old cultivation being good. A heavy storm experienced immediately after planting J.7–8 and J.5–6 compacted the soil to a greater extent in the former area, thus preventing so good a germination being obtained as in the newly broken up grassland of J.5–6. Terminal loss data secured when the plants were six weeks old showed that definite varietal differences existed then, for Acala 16–7 had significantly less damage throughout the six tests. Low loss of terminals also occurred in the New Boykin variety in several of the tests, notably in J.9–10 and J.15–17. Moisture penetration was apparently much greater in the second-year-old cultivation than in the old cultivations, which is in keeping with results obtained in previous seasons. In J.11–12 a much more vegetative type of plant developed which failed to set many flowers and accordingly produced a correspondingly poor yield. Counts of the fruiting nodes on 60 plants of the Miller variety in each test indicated that in late January the plants in J.15–17 averaged 42 forms, which was from 200 to 400 per cent. greater than on the rest of the companionate cultivations, and that only 26·7% of the crop had been shed, as compared with an average of 68·3% for the other plants.

The analyses of the yields obtained may be summarised as follows :—

J.5–6. F. (ratio of mean squares) for varieties was not significant.

J.7–8. F. for varieties was not significant, nevertheless a significant difference was obtained in which Acala 16-7 significantly exceeded Miller, Indio-Acala or New Boykin. This difference will, of course, have to be accepted with extreme caution.

J.9–10. F. for varieties was highly significant, Oklahoma Triumph significantly exceeding Indio-Acala and New Boykin.

J.11–12. F. for varieties was not significant.

J.13–14. F. for varieties was not significant.

J.15–17. F. for varieties was highly significant for the first picking, Oklahoma Triumph significantly exceeding New Boykin, Miller, Indio-Acala and Acala 16–7, while Half and Half significantly exceeded Miller and Acala 16–7. For the second picking, F. for varieties was not significant. For the total yield, F. for varieties was significant, Oklahoma Triumph significantly exceeding each of the other five varieties between which there was no significant difference, although Half and Half yielded appreciably higher than the remaining varieties.

The average yield in each of the older cultivations failed to exceed 125 lb. seed cotton per acre, whereas the second-year-old cultivation averaged 1,105 lb., with the two quickest maturing varieties producing 1,344 lb. and 1,134 lb. per acre respectively.

The yields produced clearly indicate once again the value of planting cotton in the first two years following the breaking up of long established virgin grassland. Probably owing to the late planting, the crops in the first year following the breaking up of three-year established Rhodes grass did not yield such outstanding gains over old cultivations as were obtained in either the second year following virgin grassland or as have been produced in similar comparisons in past seasons.

The usual soil sieving tests were taken early in August, at the end of the season, immediately after ploughing. No rain fell during the sampling period, so that significant differences obtained can be accepted as fairly reliable indicators of the condition of the surface six inches of each age of cultivation. Twenty samples were taken from each of the following borders :—J.6, J.7, J.13, J.15. The results obtained indicated as in previous years, that there was a tendency for the newer cultivations to have fewer clods, except in the case of clods greater than $1\frac{1}{2}''$ diameter. It is suggested that this difference may have been due to the adherence of the soil to the large roots of the old stools of grass which were still common in the upper six inches of soil in the newer cultivations.

Alternate Cropping Rotations.—The usual series of alternate cropping rotations in which comparisons are made of the value of planting cotton after either maize, Sudan grass, giant setaria or saccaline (sweet sorghum) was continued. The cotton areas were planted early in December and with the ample moisture present, vigorous growth of the young plants resulted. Considerable shedding occurred during the heat waves and the ultimate crops of cotton were so poor that no yields were taken.

Oats-Maize-Cotton Rotation. — The cotton crops were so unsatisfactory in this experiment that no yields were taken.

Rhodes Grass-Cotton Rotations.—Three experiments testing the merits of this rotation were conducted during the season, two being on soil of only moderate fertility where the main problem is to improve the permeability of the surface soils of old cultivations sufficiently to allow of ample storage of subsoil moisture to carry a cotton crop through dry periods, while the third experiment aims at not only impounding ample moisture, but reducing the production of nitrates to a level that will enable profitable cotton crops to be grown with a satisfactory degree of surety.

In one experiment on the less fertile soil a comparison was made of cotton planted in the first and the third year following the breaking-up of aged Rhodes grass areas. This experiment could not be planted until December 12th, which, based on the results obtained in late plantings of previous years, would ordinarily not yield a crop worth picking. Plant growth was rather restricted throughout the season, however, due to the combination of low soil fertility, the effect of the preceding long period of growth of Rhodes grass and the hot, dry spell experienced in January. The more permeable surface soil of the newly broken up grassland apparently trapped more of the storm rains, the average yield of the first year of cotton plots being 313 lb. seed cotton per acre as compared with 248 lb., or a gain of 26%.

In the second experiment, which was planted on less fertile soil, a greater degree of slope existed lengthwise of the rows, and consequently there was less trapping of the beating storms than was accomplished in the experiment described above. The second experiment embraced a comparison of cotton in the first year following the breaking up of Rhodes grass of three years' establishment and cotton on land that had had seven succeeding crops of cotton, both treatments being on land in the seventeenth year of cultivation from the virgin grassland. Although this experiment was planted a fortnight earlier than the companionate experiment, plant growth was not as good owing to the lesser absorption of the storm rains. Yields were thus poor, the continuous cotton plots averaging only 120 lb. seed cotton per acre as compared with 215 lb. in the areas following Rhodes grass—a gain of 79% in favour of the latter area.

In the experiment on the more fertile soil, where the first year of cotton following three years of establishment of Rhodes grass was compared with cotton following three successive cotton crops following thirteen years of various annual croppings, no yields were obtained, the late-November plantings making rank growth which shed so severely during the periods of high temperatures that no crops were produced.

The results obtained over all of the areas where comparisons were possible of cotton following Rhodes grass and cotton following succsesive croppings of cotton would appear to indicate that even in seasons in which planting cannot be done until late in November, some benefit is obtained through planting following Rhodes grass of at least three years' establishment, if the soils are not very fertile alluvial loams and clay loams capable of high nitrification at mid-season. On the latter soils no benefit appears to be gained through practising this rotation when cotton is planted late. As the yields obtained in late-planted cotton following Rhodes grass on any part of the Research

Station were not as large as those obtained in the second year of cotton following virgin grassland, it is possible that longer establishment of the Rhodes grass on fertile soils may be more beneficial. A late-October planting of cotton following Rhodes grass established in March, 1933, produced an average of 805 lb. seed cotton per acre this season.

Row and Plant Spacing Test.—The results which have been obtained in recent years in plant spacings in rows 4 ft. 6 inches apart have indicated that on alluvial soils, 1 ft. spacings of single plants may yield better than 2 ft. spaced plants. As there has been a growing tendency for the farmers to reduce the row widths to less than the usual 4 ft. 6 inches, an experiment was conducted this season which embraced testing the merits of 2 ft. and 1 ft. single plant spacings in row spacings of 4 ft 6 inches and 3 ft. 6 inches on old cotton cultivations and on land in the third year following the breaking-up of virgin grassland.

A good stand of plants was obtained, and their early development was excellent. However, following the occurrence of the heavy rains interspersed with such intense heat waves, plant growth over both experiments became very uneven and the consequent yields, while fairly good, were very erratic and inconclusive.

The following observations regarding branching habits were made:—

On the older cultivation no significant difference was obtained between row spacings regarding the number of vegetative branches per plant. There was a highly significant difference, however, between the 2 and 1 ft. spaced plants in each row spacing, the 2 ft. spacing naturally having more vegetative branches. The difference in the number of fruiting branches per plant was likewise not significant between row spacings. The 2 ft. spaced plants bore more fruiting branches than did the 1 ft. spacing in both row spacings, but a significant difference was obtained in only the 4 ft. 6 inch row spacing. Similar analyses of the data obtained on the three-year-old cultivation indicated that no significant differences existed in regard to any treatment, although there was a tendency for the 2 ft. spaced plants to have more vegetative and fruiting branches than the 1 ft. spaced plants irrespective of row spacing.

Flower counts indicated, as was to be expected under the abnormal conditions experienced, that the 1 ft. spacing produced a larger number of flowers for the season. No significant difference was obtained between row spacings, however.

ENTOMOLOGY.

Seedling pests were of little importance though the flea beetle, *Nisotra breweri* Baly., caused damage to young plants in two somewhat isolated crops. A spring influx of the Australian plague locust, *Chortoicetes terminifera* Walk., affected cotton stands in many districts in early summer. The more important insects associated with cotton appeared in mid-season. The loopers, *Anomis flava* Fabr. and *Antarchæa chionosticta* Turn., were much more abundant than for some years past, and destroyed or partially destroyed fairly large areas where larval populations were high, and the control spray, lead arsenate-molasses-water (1 lb.—1 gal.—12 gal.) was not promptly applied. The corn-ear worm, *Heliothis armigera* Hb., though generally distributed in most cotton districts, appreciably affected yields in few areas, and then only on crops which had been planted late; few migratory swarms from weeds and other hosts were recorded. Infestation by the jassid, *Empoasca terrareginæ* Paoli, which is generally expected in the autumn, was more localised than usual, while the pink bollworm, *Platyedra scutigera* Hold., which seriously affected cotton harvested late in the 1938–39 season, was this year of no appreciable importance.

PROGRAMME for 1940-41.

The programme for the year included tests of insecticides for bollworm control on the Research Station, corn-ear worm studies in irrigated areas, and maize trap crop demonstrations.

Yields from cotton dusted with lead arsenate (lead arsenate 9 : kaolin 1) were consistently somewhat lower than those from plots treated with a swabbing solution with the formula lead arsenate 1 lb. : molasses 1 gal. : water 6 gal. Neither treatment, however, increased actual yields of seed cotton. It is probable that corn-ear worm infestation was not sufficiently high to warrant treatment. There can be little doubt that some measure of both the potential crop yield and the significance of any given corn-ear worm population must be obtained before the use of insecticides for the control of this pest can be placed on a sound economic basis. This problem should be less acute on irrigated than on dry cotton. In the former, yields are high enough, if the cultural treatment of the crop is adequate, to warrant a reasonable expenditure on insecticides and the corn-ear worm is less subject to sharp fluctuations in population levels. Substantially increased yields following the use of the lead arsenate swabbing solution have already been obtained in irrigated cotton.

Cotton yields in areas planted with maize trap crops were not significantly higher than those on similar areas planted elsewhere. Sometimes they were lower—a result which is not attributable to the activity of the corn-ear worm, for in no case was this insect a limiting factor in the yields. The apparent anomaly seems to be due to the fact that growers who use maize trap crops are invariably clean farmers; in 1939–40 a peculiar incidence of flood rains at a critical stage in the growth of the plants frequently proved more harmful to cotton free from weeds in February than to cotton grown under lax treatment with its concomitant of luxurious weed growth. The attractant power of maize to the corn-ear worm moths was determined by egg counts on the interplanted cotton. A distinct gradation in the number of eggs was apparent between successive strips of maize, the highest recordings being at the middle point and the lowest in cotton rows close to the maize.

SOUTH AFRICA

PROGRESS REPORTS FOR THE SEASON 1939-40.

INTRODUCTORY NOTE

BY

F. R. PARNELL.

Staff.

There was no loss of staff as a result of the war till the end of the season, hence the reports deal with a full season's work. Many officers left for military service before their results had been fully analysed, however, and the reports are somewhat incomplete in places for this reason.

Barberton.—In the section of Plant Breeding and Field Experiments, Messrs. Fielding, Rose and Ruston are on military service, and the work will be considerably curtailed.

Of the staff of the Insect Pest Control Section, Messrs. Marshall, Rainey and Wickens are on military service, and Mr. Parsons expects to be going shortly. The work of this section will have to be suspended, therefore, for the duration of the war.

Magut.—This Station was closed down shortly after war was declared and Mr. Bowmaker devoted his time to Native cotton plots in Natal. He has since gone on military service.

Swaziland.—The services of Messrs. Lochrie and Hutchinson have been placed at the disposal of the Administration, but their work has been continued much as usual.

Commercial Crop.

There was a small increase in the crop, but only a little over 2,000 bales (400 lb.) was produced, since the market prospects were not very encouraging. There has been difficulty in selling this small quantity at a remunerative price and little immediate increase in production can be expected.

Native Cotton.—The trial plots in Natal were subjected to very severe drought and the yields were mainly poor, though comparing very favourably with those from other crops. In general, the best results were obtained from the hotter, less exposed situations away from the coast, and certain areas have been noted as promising. Stainers again proved to be a factor in many places, but might be of less importance if larger acreages were grown in one area.

In Swaziland a new start has been made with the native cultivation and it is intended to give cotton-growing a thorough trial.

EXPERIMENT STATIONS.

A very successful season's work was carried out and, in spite of the shortening of the season by drought, excellent yields were obtained. A most satisfactory feature of the variety trials was the consistently good yields given by 5143, the strain recently distributed for general cultivation. The value of *secondary* selection is again demonstrated, this time by a " Progress " trial, which shows the steps forward made in the evolution of 5143 from U.4 Bulk. It may be mentioned that 5143 still retains very considerable genetic variance.

The analysis of the fruiting behaviour of the plant is of considerable interest, but requires to be supplemented by similar work in a season in which there is no set-back from climatic or other evident causes. It will then be possible to see whether, given good growing conditions, the plant is able to continue its fruiting over a longer period than has been usual for the past few seasons. Further investigation is required to determine whether nitrogen-starvation of the leaf is a factor contributing to early closing down of the crop here. This subject is of importance on both the plant-breeding and pest control sides.

Most of the U.4 strains are early types that put on a heavy crop very rapidly, this being the result of selection for the best economic returns over many seasons. The leaf is on the small side and the fruit/leaf ratio very high, thus the nitrogen drain on the leaf would be severe. The very earliest types, U.4/4/2 and its derivatives, which carry the heaviest crop for their size, have been discarded here as they close down too quickly except in conditions encouraging vigorous growth. The best established strain, 5143, is rather slower in starting to fruit, combines stronger growth with heavy fruiting and closes down less suddenly in adverse conditions. Are these differences connected with the nitrogen balance between leaf and fruit ?

The possibility that heavy mortality in the second bollworm generation on cotton is due to protein deficiency, referred to in the Entomological report, is of interest in the same connection.

COTTON EXPERIMENT STATION, BARBERTON.

COTTON BREEDING AND FIELD EXPERIMENTS

BY

D. MACDONALD W. L. FIELDING AND D. F. RUSTON.

Introduction.

The proposed programme of work on cotton breeding for the season was successfully accomplished, but owing to the departure of Messrs. Fielding, Rose and Ruston on military service, it has not been possible to analyse fully all the data obtained from the season's work. No selection work was carried out on pure U.4 material as, in view of war risks, the seed from single-plant selections made in 1938–39 was not planted out in progeny plots, but stored in insect- and vermin-proof containers until more settled conditions prevail. A number of variety tests consisting mainly of U.4 strains was carried through successfully, while hybridization work begun in previous seasons was carried a stage further.

Meteorology.

The season's rainfall of 37·91 inches, while less than that of the previous season, was well above the average for the Station. Good rains in July and September enabled land to be worked early, and good seed beds were prepared. A small amount of cotton was planted towards the end of October, but the main planting was carried out in the first week of November. The rainfall for the ensuing three months was excellent and this, accompanied by uniformly good temperature conditions, enabled the plants to develop rapidly, and to lay the foundations of a very heavy crop. During February and March mean maximum temperatures were consistently high, while no effective rain fell between the end of January and March 15th. The hot dry conditions stimulated flowering, but records showed that practically none of the bolls set after the end of February were matured. In spite of this, the heavy crop set by mid-February matured well, and yields of lint of from 400 to over 600 lb. per acre were reaped. Conditions in the district were similar and uniformly good yields were obtained on most farms.

Genetics and Breeding.

Variety Trials.—During the season ten variety trials, containing in all 82 different strains, were carried through successfully, significant results being obtained in all trials. Stands and growth were good throughout, and very little insect damage of any kind was done during

the season. Although stainers (*D. nigrofasciatus*) were present in considerable numbers towards the end of the season, practically no damage by *nematospora* was visible.

In all trials the strain 5143, which is now in general cultivation throughout the district, was used as a control and finished up with a mean yield, over all trials, of 476 lb. *lint* per acre. The excellent conditions that prevailed from planting, up to the latter part of February resulted in the highest average yield of lint per acre, from all strains, ever recorded on the Station.

The striking yield increases of the 5143 re-selections over their parent, as shown in Table I of the 1938–39 Report, were not fully maintained at Barberton this season, on account of the very high yields obtained from all strains under good conditions. On the other hand, in Swaziland, where conditions were not so good, resulting in lower yields, the superiority of the 5143 re-selections over the parent was maintained.

In a Variety Trial of re-selections from the 921 family, four of the most recent selections gave very significant increases over 5143, the yields of these four re-selections, ranging from 585 to 623 lb. lint per acre, while 5143 yielded 547 lb. The significant increase in yield was in a large measure accounted for by the high ginning percentage of the 921 selections. While the ginning outturn of 5143 in this trial was 37·6%, three of the 921 selections gave an average figure of 40·3%. The excellent opening qualities of the 921 family, referred to in previous reports, were fully maintained in the newer selections.

A " Progress " trial was carried out comparing the original U.4 Bulk with strains directly descended from it for five generations. The yield figures, together with percentage increases, are given in Table I.

TABLE I.

" PROGRESS " VARIETY TRIAL.

Strain and Origin.	*Yield, lb. Lint per acre.*	*% of Bulk.*	*Date of Putting into general cultivation.*
U.4 Bulk	385	100	1929–30
U.4/4	454	118	—
U.4/4/052	478	124	1935–36
052/5143	562	146	1939–40
5143/6130...	566	147	—
5143/6128...	569	148	—
P=·05	32	8	

Despite the high yields of lint obtained in this trial, very significant differences are shown between the three strains of U.4 issued for general cultivation in the previous nine years.

Of the original Harland's (U.4×Cambodia)×U.4 strains, the five lots carried forward were included in a trial with 5143 and some of its re-selections. One of the 5143 re-selections, 6130, gave a significantly higher yield than the parent and very significantly outyielded all the Cambodia crosses. 5143 itself also outyielded all the above crosses, but with two out of the five crosses the increase just missed being significant. The lint characters of 5143 are, however, so much superior to those of all the crosses, that all except one of the latter are being discarded. This one is being retained purely as an indicator for comparison, as regards lint characters, with the recent (U.4×Cambodia)×U.4 backcrosses.

Hybridization.—In the previous season backcrosses had been made between 5143 and 5149 and the crosses of these strains with Cambodia made a year earlier. This season the 5143 backcrosses proved definitely the better, in plant characters generally and particularly in hairiness. Good plants of each group, selected for hairiness, were again backcrossed by the best strains of their respective U.4 parents.

The main object of such crosses is to obtain greater hairiness on good U.4 types, from the point of view of resistance to both jassid and *Lygus*. In searching for hairier types it was found that MU.8A, an Indian Upland type received from Hutchinson, was the most markedly hairy *hirsutum* type we have seen. This strain has now been used in further crosses with U.4.

Reference to work in connection with " quality " of lint is deferred to next reason's report.

EXPERIMENTS.

Minor Elements.—In considering why cotton on the Barberton Station has shown such susceptibility to *Alternaria* disease, it was felt that the possibility existed of the soil being deficient in certain of the common minor elements. Accordingly a randomized block experiment was carried out to test the effect of a range of these elements on the germination, development, general health and final yield of cotton. The elements, boron, copper, magnesium, manganese and zinc, were tried individually and in various combinations.

No differences of any sort could be seen in the field and the figures relating to germination, green weight samples at various stages, flowering and final yield, showed no significance for treatment effect.

In no part of the experiment did any sign of *Alternaria* appear during the season.

Crop Development and Loss.—Reference was made in last season's Report to preliminary investigations in an attempt to follow the development of crop from square to boll throughout the season,

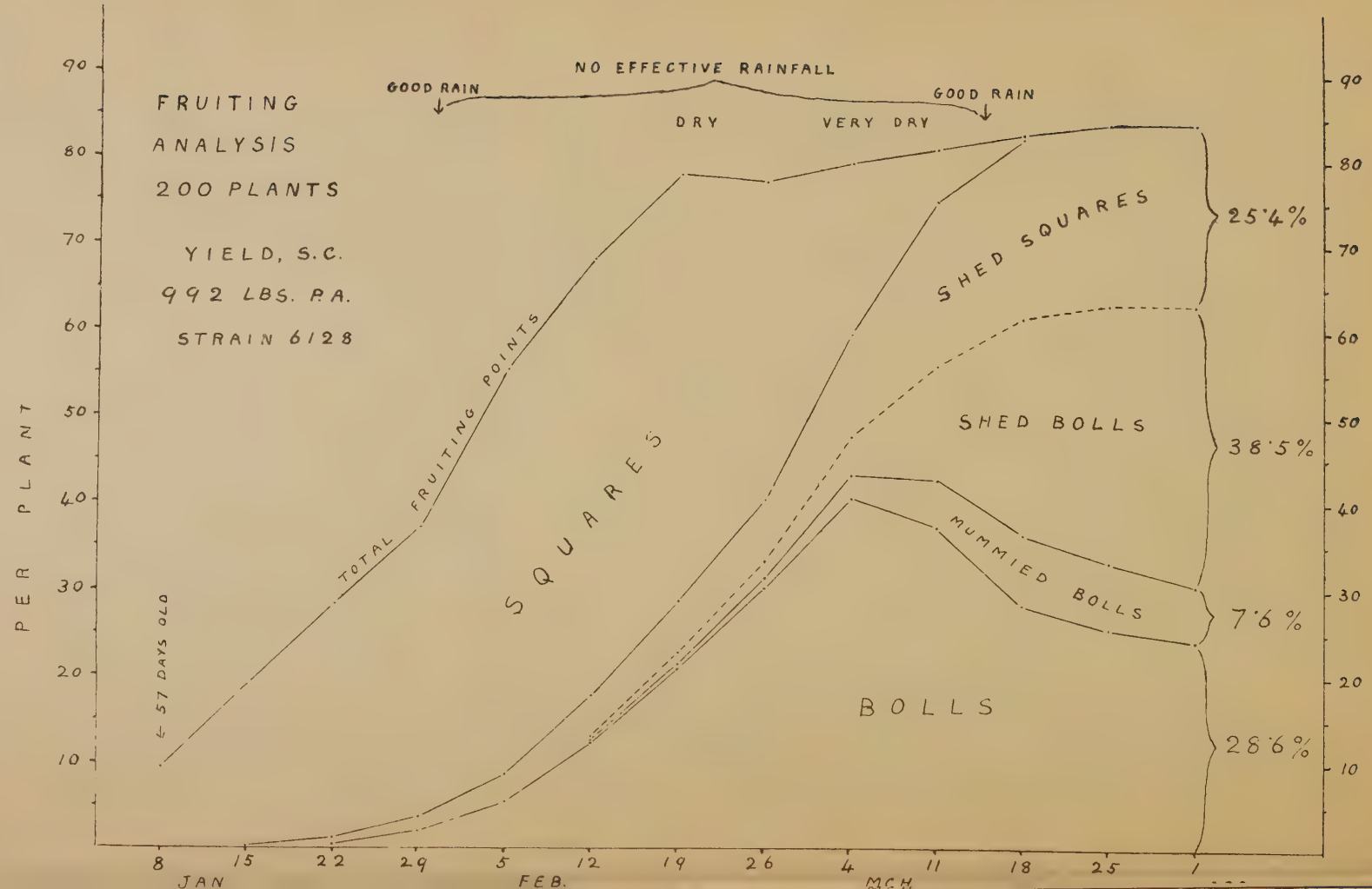
together with losses and their causes, so far as could be identified. In any such recording work the plant is subjected to what may be termed " handling effect " which undoubtedly affects its development. The layout of this season's experiment was designed so that, in addition to getting accurate information as to the cause of crop production and loss, a reasonable measure of any loss of crop due to differential handling effect could be ascertained.

In a uniform field of strain 6128 a randomized block experiment containing three treatments, with ten repetitions, was laid out. The treatments were (*a*) non-handled rows, (*b*) flower count rows, (*c*) fruiting-point count rows, these treatments being separated by guard rows. The handling on the recorded rows was as follows :— *Flower count rows*—counts made daily, moving branches gently where necessary to disclose flowers. This, of course, also entailed daily walking along the row. *Fruiting-point rows*—a random sample of 12% of the plants in the rows was taken and changed weekly. Weekly counts of all squares, flowers, bolls, mummied bolls, and shed points were made on the sample plants. This record entailed considerable handling, but did not occur on an average more than twice per plant during the season. All plants in this treatment were subject to some treading weekly.

From a further sample of 600 plants, also changed weekly, collections were made every second day of all shed material, both squares and bolls so collected being divided into groups according to size, and examined individually to observe whether shedding was due to insect damage or other causes. The average number of shed points per plant from both samples tallied very closely throughout the season.

Figure 1 shows graphically the fruiting analyses of the 12% sample taken from the fruiting-point count rows throughout the season. It shows for any given date the division of total fruiting points into squares, bolls, shed squares, shed bolls, and mummied bolls. The division of shed points into shed squares and shed bolls was obtained from the analysis of the shed material collected from the 600 plant samples. In effect this division represents the cumulative flowering curve.

Square production started in the beginning of January and went on rapidly until mid-February, when it stopped very suddenly, presumably on account of the dry conditions. The good rain of March 15th failed to bring about a fresh flush, as the plant was already closing down rapidly.


FRUITING
ANALYSIS
200 PLANTS
YIELD, S.C.
992 LBS. P.A.
STRAIN 6128
NO EFFECTIVE RAINFALL
GOOD RAIN
GOOD RAIN
DRY
VERY DRY
PER PLANT
90
80
70
60
50
40
30
20
10
TOTAL FRUITING POINTS
← 57 DAYS OLD
SQUARES
SHED SQUARES
SHED BOLLS
MUMMIED BOLLS
BOLLS
25·4%
38·5%
7·6%
28·6%
8
15
22
29
5
12
19
26
4
11
18
25
1
JAN
FEB.
MCH

Until February 26th shedding was very light and confined almost entirely to squares. It then increased and from March 4th onwards it was very heavy for both squares and bolls, practically all new bolls being shed from 7–10 days after they had set. (Records on date-tagged material in another experiment showed that practically none of the bolls set after the end of February matured). When rain was received, on March 15th, there were practically no squares left on the plant. Only a slight shedding of bolls occurred after this date.

The final fruiting analysis shows that of the total fruiting points produced only 28·6% developed into bolls producing pickable cotton. While this percentage appears to be low, an actual yield of 992 lb. seed cotton per acre was produced, despite the adverse condition from mid-February onwards.

Analysis of the collected shed material showed that loss by insect damage was very low throughout the season, the heaviest loss, which occurred between February 18th–24th, only amounting to 0·33 bolls and 0·50 squares per plant for the week. Shedding due to other causes, mainly drought, was heaviest during the weeks February 29th–March 6th, when 3·7 squares per plant were shed, and March 10th–March 16th, when 12 bolls per plant were shed. Analysis of shed material into approximate age groups showed that boll shedding, other than shedding due to insect damage, occurred mainly 7–10 days after flowering, while squares over a fortnight old seldom shed unless damaged by insects.

In the analysis of handling effect on final yield of seed cotton a 12% sample of the plants in all three treatments was taken, each boll as it was picked being classified into " A " grade (undamaged bolls), and " B " grade (bolls partially damaged by insect or other causes). Final figures showed no significant difference between the treatments in the amount of " B " grade cotton produced. In both treatments subjected to handling effect the plants closed down earlier, and the main loss of crop indicated in Table II below was due to smaller late pickings. These were only 20% of the total crop, as opposed to over 30% for the non-handled rows. Actual yield figures are given in Table II.

TABLE II.

Treatment.	*Yield, lb. seed cotton per acre.*	*Yields as % of non-handled treatment.*
Non-handled	1,098	100
Fruiting-point count	992	90·3
Flower count	915	83·3
P = ·05	100·9	9·2

Even the small amount of handling to which the fruiting-point count plants were subjected during the season, resulted in a significant

decrease of yield, as compared with unhandled rows, while plants from flower count rows gave a still lower yield, this decrease just failing to be significant. Although total yields are reasonably high, plant growth over the experiment area was not strong; had growth been strong and vigorous, it is probable that yield differences due to handling effect would have been still more pronounced owing to the greater difficulty of recording on plants with interlocking branches, apart from the greater risk of actual damage by breakage. The effect recorded above was almost entirely concerned with the development of the plant and not with actual damage by breakage.

Nitrate Trial.—A randomized block experiment was carried out in an attempt to investigate the effect of dressings of nitrate of soda, applied at different stages in the life of the plant, on shedding, final yield and *Alternaria*. The treatments were :—

(1) *Early.*—200 lb. per acre nitrate of soda applied immediately after thinning on December 19th.

(2) *Late.*—200 lb. per acre nitrate of soda applied in mid-season, 22nd February.

(3) *Early plus late.*—400 lb. per acre in two applications as (1) and (2).

(4) Nil.

The analysis of weekly flowering, % bolls picked from flowers produced, and boll weight from the different treatments are given along with actual yield figures in Table III.

Table III.

Week ending	*Jan.* 20.	*Jan.* 27.	*Feb.* 2.	*Feb.* 9.	*Feb.* 16.	*Feb.* 23.	*Mar.* 2.	*Mar.* 9.
Flowering per Plant—								
Early nitrogen ...	·92	1·23	2·17	3·88	5·04	7·95	7·54	8·82
Nil	·92	1·16	2·29	4·01	4·89	7·11	6·64	7·90
% *Bolls picked from flowers produced*—								
Early nitrogen ...	68	56	55	71	54	35	11	Nil
Nil	75	70	55	65	52	46	11	Nil
Boll weight—								
Early nitrogen ...	4·2	5·0	4·5	4·4	3·7	2·5	—	—
Nil	3·6	4·6	4·3	4·0	4·1	2·2	—	—

Yield, lb. seed cotton, per acre.	*First Picking.*	*Second Picking.*	*Total.*
Early nitrogen	531	213	744
Early and Late	535	218	753
Late	439	227	666
Nil	433	198	631
P = ·05	87	insignificant.	insignificant.

The late application on February 22nd was applied during a dry period, and as no effective rain fell until March 15th, when the crop

had shut down, it had no effect whatever. Accordingly, the data given in Table III, apart from actual yield figures, are grouped under two treatments (1) Early Nitrogen, (2) Nil.

The Table shows that until the week ending February 16th flowering was the same for both treatments; after this the flowering on the plots receiving Early Nitrogen showed an increase compared with Nil, but this had little effect on final yield, as only a very small percentage of bolls resulting from flowers produced during this period was matured. In the percentage of bolls picked from flowers produced in any given week the first two weeks of flowering showed a definite increase in favour of the Nil plots, but the total setting throughout the season for both groups was almost identical.

The differences in actual yield between the treatments are accounted for by increased boll weight on the plots receiving Early Nitrogen. This increase is consistent throughout the season, except for one week, when the bolls from Nil plots were slightly heavier.

Yield figures for the first picking show a significant increase in favour of the early, and early plus late plots, but the differences in total yield, although favouring the plots receiving early applied nitrogen, were not significant.

In the absence of *Alternaria* it was not possible to note the effect of nitrogen applications on the susceptibility to this disease.

The early application of nitrogen affected the crop visibly, giving a darker green leaf, and undoubtedly increased the early picking, but its failure to influence the number of bolls matured does not encourage the belief that the heavy shedding of the latter part of this season was directly connected with nitrogen starvation as a primary factor. It is possible, however, that the effect of the drought may have been partly due to its interference with nitrogen uptake.

It is of interest, however, that a much better-grown crop on another field did not close down so rapidly in the drought, although it was carrying a heavy crop. The actual shortage of moisture would be expected to be more serious for the stronger growth. On the other hand, the proportion of leaf to fruit was undoubtedly higher on this well-grown field during the early bolling and the drainage of nitrogen from the leaf would be correspondingly slower. It is impossible to judge, from any knowledge that has been gained here in the past, what connection there may be between faulty nutrition and early closing down of the crop.

Opening Experiment.—Past experience in the breeding work at both Gatooma and Barberton, has shown certain types to be " bad openers," either being difficult to pick, due to the cotton not coming away easily

from the open boll, or failing to give pickable cotton from an unduly large proportion of the bolls developed. In co-operation with Mr. Peat it was arranged to carry out a preliminary experiment on this problem at both Stations. This proved impossible at Gatooma, owing to dispersal of staff in connection with the war, but the experiment was carried through at Barberton.

Two " good openers " and two " bad openers " from Gatooma were grown alongside four " good openers " and one " bad opener " of Barberton strains, on a randomized block lay-out with 12 repetitions and 2-row plots. As was to be expected, the Barberton strains were more at home than those from Gatooma, giving better general development and being much less quickly affected by the drought. The main results of the records taken are given below.

Flowering and Setting.—Counts were made, on 1-row plots in 8 blocks, of flowers, bolls picked, and mummied bolls (that dried up on the plant without giving pickable cotton). The figures are given in Table IV.

TABLE IV.

FLOWERING AND SETTING.

(8 Blocks, 1-row plots.)

Strain.	*Flowers per Plant.*	*Bolls Picked.*		*Mummied Bolls.*		*Sheds % of flowers.*
		No.	*% of flowers.*	*No.*	*% of flowers.*	
Gatooma 7L.1	37·8	11·8	31·2	2·9	7·7	61·1
Gatooma 7L.5	45·0	13·5	30·0	3·5	7·8	62·2
Gatoom 7L.26 (B.O.) ...	44·4	13·2	29·7	4·8	10·8	59·5
Gatooma 8L.1 (B.O.) ...	41·2	14·0	34·0	5·1	12·4	53·6
Mean of 2 Good openers ...	41·4	12·7	30·6	3·2	7·8	61·7
Mean of 2 Bad openers ...	42·9	13·6	31·9	5·0	11·6	56·6
Barberton 6130	51·2	15·2	29·7	3·3	6·5	63·8
Barberton 6135	48·8	16·1	33·0	3·3	6·8	60·2
Barberton 6250	48·0	16·5	34·4	2·7	6·6	60·0
Barberton 0268	47·1	16·5	35·0	2·9	6·2	58·8
Barberton 9264 (B.O.) ...	50·9	16·4	32·2	5·9	11·6	56·0
Mean of 4 Good openers ...	48·8	16·1	33·0	3·1	6·3	60·7
1 Bad opener ...	50·9	16·4	32·2	5·9	11·6	56·0

N.B.—Strains marked (B.O.) are bad openers

It will be seen that the Barberton strains gave more flowers and a correspondingly greater number of bolls picked. As between good and bad openers, the only difference was that the latter regularly carried more mummied bolls. This was *at the expense of sheds* and did not reduce the percentage of bolls picked.

The low boll/flower ratio in all strains is due to the very heavy shedding of young bolls, from late February onwards, as a result of the drought.

Stripping.—An attempt was made, by stripping off part of the flowers, to relieve the plant of some of its crop in order to see whether this would help the bad openers to finish better.

Late stripping (removing all flowers after the peak of flowering) had no effect, since the drought intervened.

Alternate-day stripping (removing all flowers 3 days a week throughout the season) was also carried out on 4 blocks. This produced less effect than expected, as the number of bolls matured was not altered. The stripped rows stood the drought slightly better and produced more late flowers, though these were shed. No differential effect could be detected between good and bad openers, all strains behaving similarly and giving the following mean figures :—

	Control Rows.	*Stripped Rows.*
Flowers per plant	47·7	59·4(*a*)
Bolls picked per plant	15·6	15·7
Boll weight (all pickings)	3·89	4·07
Yield of seed-cotton	100%	105·7%
% " A " grade bolls (*b*)	75·2	81·1
% " B " grade bolls	24·8	18·9
Mummies as % of bolls held—		
3 bad openers	26·0	22·9
6 good openers	17·7	14·7

(*a*) Of which 24·8 were removed in stripping.
(*b*) " A " grade were complete undamaged bolls ; " B " were defective bolls giving pickable cotton.

Stripping thus produced a small effect in increasing boll weight (and yield in proportion) and decreasing the percentage of defective bolls and also of mummied bolls.

Yield.—Data for yield of seed-cotton are given in Table V.

TABLE V.
YIELDS OF SEED-COTTON.

Strain.	*Total seed-cotton lb. per acre.*	*B. grade %*	*% of Yield by Pickings.*			
			I. 8/4/40.	*II.* 15/4/40.	*III.* 25/4/40.	*IV.* 27/5/40.
G. 7L. 1	709	19·7	39·0	33·3	14·0	13·7
G. 7L. 5	751	15·9	26·9	31·8	18·8	22·5
G. 7L.26 (B.O.)	694	19·0	33·6	32·5	14·5	19·4
G. 8L. 1 (B.O.)	810	14·3	23·2	32·6	17·2	27·0
Mean	741	17·2	30·7	32·6	16·1	20·7
B. 6130	1,105	17·3	12·9	33·7	19·3	34·1
B. 6135	1,153	18·1	22·4	36·7	17·9	23·0
B. 6250	985	15·8	17·1	27·6	21·4	33·9
B. 0268	1,063	16·4	17·0	27·2	21·7	34·1
B. 9264 (B.O.)	865	23·8	21·7	30·6	17·3	30·4
Mean 4 good openers	1,077	16·9	18·2	31·2	19·5	31·1
One bad opener...	865	23·8				

G = Gatooma strain ; B = Barberton strain.

Of the Gatooma strains there were no marked differences between good and bad openers as regards yield, % of defective bolls (B. Grade) or time of opening. The Barberton strains gave much higher yields,

but the bad opener, 9264, was notably the lowest and showed a higher % of B. grade. The Barberton strains matured their later settings better than the Gatooma strains since the drought affected them at a less early stage.

Boll Weights.—The ability to mature the amount of crop held can be judged from the variation in boll weight through the season, *vide* Table VI.

TABLE VI.

Boll Weights by Pickings.

Grade A, Whole Picking divided by Number of Bolls.

(8 Blocks.)

	Mean boll-weight, 4 pickings.	*P.1—P.4 as % of Mean.*			
		1 8/4.	2 15/4.	3 25/4.	4 27/5.
G. 7L. 1	4·03	116·6	102·5	95·9	71·2
G. 7L. 5	3·93	117·1	104·9	101·5	80·9
G. 7L.26 (B.O.)	3·78	119·3	111·1	98·7	70·9
G. 8L. 1 (B.O.)	4·02	119·4	104·5	107·2	81·6
Mean	3·94	118·1	105·8	100·3	76·2
B. 6130	4·65	120·0	108·0	107·3	85·2
B. 6135	4·85	120·0	102·9	107·8	75·1
B. 6250	4·16	124·3	104·1	112·7	84·9
B. 0268	4·49	116·5	110·7	108·5	85·3
B. 9264 (B.O.)	4·05	123·0	102·5	107·6	86·4
Mean	4·44	120·8	105·6	108·8	83·4

It will be seen that the boll weight fell as the season advanced in all cases, but the Barberton strains carried a heavier boll and maintained their boll weight in later pickings better than the Gatooma strains – this in addition to having given higher yields and heavier late pickings. There is no indication that the bad openers were bad " finishers " from this point of view, and 8L 1, the worst opener of the Gatooma strains. was the heaviest yielder, gave the best late pickings and maintained its boll weight better than all the other Gatooma strains.

Opening.—The whole crop on the Station opened well, but the following differences were noted in this experiment.

G. 7L 5, B. 6250, B. 6135 } Very good opening, boll segments very widely reflexed, cotton hanging out very loosely.

G. 7L 1, B. 6130, B. 0268 } Very good opening, reflexion less extreme, cotton very easily pickable, but less loose and less likely to fall out.

G. 7L 26 (B.O) Tendency to stickiness in picking.

G. 8L 1, B. 9264 } (B.O) Not opening well, more sticky in picking, but no actual loss of crop from failure to mature.

Conclusions.—Differences in opening were not connected, in this experiment, with the ability of the plant to mature its crop.

The records show that, of the Gatooma strains, 8L 1, the worst opener, was the heaviest cropper and matured its bolls best. Of the

Barberton strains the bad opener, 9264, gave the lowest yield and slightly more B. grade bolls, but was about the average in finishing.

In other conditions bad opening may be due to failure to mature, but here it appeared to be due to some hereditary difference in boll behaviour. There may be a connection between failure to cut off dead bolls (greater % of mummies held) and failure of the mature boll to open and expose the seed-cotton freely.

Rotation Experiment.—This experiment on the loam soil was continued as usual, final yields showing that cotton after fallow outyielded all other treatments for the seventh successive year. The yields of seed cotton per acre for the six treatments are given below, Table VII.

TABLE VII.

Treatment.	*Yield of seed-cotton.*
Cotton after Fallow	1,290 lb. per acre
,, ,, Cotton	884 ,, ,, ,,
,, ,, Tepary Beans	871 ,, ,, ,,
,, ,, Maize	615 ,, ,, ,,
,, ,, Sunflower	559 ,, ,, ,,
,, ,, Soya Beans	539 ,, ,, ,,
P=·05	190

Flower tagging on sample plants from all treatments again showed that sunflowers and maize treatments produce an earlier crop, but go off badly towards the end of the season. This was particularly noticeable this season when the very dry spell during February and early March affected the sunflower treatments earlier than any other, the result being a very low yield. As usual the Soya bean treatment gave the poorest crop.

Seed Storage.—The intended experiments on this subject were not carried out in full, but preliminary experiments showed that sun-drying of both acid-treated and untreated seed on a concrete floor down to a relative humidity of 20% did not impair germination. It is of interest to record that such seed of 20% R.H., after being dried to constant weight in a water oven at 95° C. for a number of days, gave a germination of over 90%. It should be noted that the germination test was carried out after the seed had been exposed to the atmosphere for fourteen days. On the other hand, seed of a relative humidity of 46% taken direct from the store was completely killed by oven drying.

Compost Experiment.—The permanent compost experiments were under maize during the season and are dealt with in the Rotation Crop section of the Report.

Investigations on Sampling for Lint Length and Ginning Percentage.—These investigations, referred to in previous reports, were continued during the season. The departure on military service of the two members of the staff carrying out the investigations has rendered impossible the analysis of the data obtained at the time of writing this report, and a detailed consideration of the results must be postponed.

Spinning Test Samples.—Arising out of the Memorandum of the Scientific Advisory Committee concerning Spinning Tests, a large number of samples has been sent to the Shirley Institute in an attempt to determine what precautions are necessary to ensure that samples are reasonably comparable.

Two of the strains forwarded for spinning tests last season proved to be an " anomalous pair," *i.e.*, while giving the same measurable hair characters they gave very different spinning values. At the request of the Shirley Institute large samples of lint of the two strains have been forwarded for further investigation.

Summary.

(1) The departure of three members of this section on military service made it impossible to analyse completely all the data obtained from the season's work.

(2) Although a very high rainfall of 37·91 inches was recorded, no effective rain fell between January 30th and March 15th.

(3) Despite the drought, which resulted in a very early closing-down of the crop, the highest yields of lint ever recorded on the Station were obtained.

(4) The crop suffered little from insect damage or other diseases.

(5) Breeding work on cotton was mainly confined to U.4 strains and U.4 × Cambodia crosses. The results of variety trials are discussed and a Table is included showing the progressive improvement in yield of the strains issued for general cultivation in the past 10 years. The outstanding superiority of re-selections of 5143 over the parent, mentioned in the previous season's report, were not fully maintained. Reasons for this are suggested. Hybridization work between U.4 and other strains was continued.

(6) No significant effect was obtained in the growth development or final yield of cotton by the application of a range of minor elements to the crop.

(7) Investigations into the development and losses of crop from bud to boll, along with their causes, are reported on.

(8) The effects of applications of nitrate of soda at different stages of the life of the cotton plant on flowering, boll-setting, boll weight and final yield are discussed.

(9) An experiment was carried out to investigate the cause of good and bad opening in different strains of cotton. Good- and bad-opening types of strains bred at Gatooma and Barberton were used. Under conditions of the past season here, bad opening was not connected with the ability of the plant to mature its crop, but appeared to be due to hereditary difference in boll behaviour.

(10) Results obtained from the long-term rotation experiment are tabulated.

COTTON EXPERIMENT STATION, BARBERTON.

DAILY RAINFALL, SEASON 1939–40.

Date.	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*
1	—	—	—	0·02	—	—	—	0·05	—	—	0·38	—
2	—	—	—	—	—	—	0·05	0·02	0·07	0·10	0·49	—
3	—	—	—	0·04	1·35	2·84	0·03	—	0·19	0·42	—	0·02
4	—	—	—	0·18	0·68	0·04	—	—	—	—	—	—
5	—	—	—	0·01	0·29	—	0·14	—	—	0·05	1·69	—
6	—	—	—	—	0·02	—	—	0·43	0·31	0·03	—	—
7	—	—	0·03	0·01	—	—	—	0·02	0·06	—	—	—
8	0·37	—	0·09	—	—	—	—	—	—	—	0·02	—
9	0·09	—	—	—	0·13	—	0·03	0·03	—	—	—	—
10	0·05	—	—	—	—	—	—	—	0·12	—	—	—
11	—	—	0·94	—	—	—	—	0·21	0·18	—	—	—
12	—	—	0·02	—	—	—	—	—	—	—	—	—
13	—	—	—	—	0·16	1·48	—	—	—	—	—	0·03
14	0·22	—	0·06	—	—	—	—	—	—	—	—	—
15	0·50	—	0·01	—	—	—	0·03	—	—	—	—	—
16	0·03	0·04	0·45	—	1·11	—	0·50	—	1·41	0·05	—	0·05
17	0·71	0·02	0·82	—	0·01	—	0·12	—	0·06	—	—	—
18	0·10	—	—	—	—	—	0·62	0·41	0·14	0·85	—	0·86
19	—	—	—	0·37	—	—	1·75	—	0·25	0·12	—	0·74
20	—	—	—	—	—	—	0·15	0·05	0·10	—	—	0·28
21	—	—	—	0·03	—	—	0·15	—	—	—	—	—
22	—	—	—	0·10	0·02	—	—	—	—	—	—	—
23	—	—	—	—	—	0·59	—	—	1·01	—	—	0·03
24	—	—	—	0·59	—	0·03	—	—	0·20	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	0·08	—	0·47	0·33	—	—	—	0·51	—	—
27	—	—	0·06	—	0·94	0·12	0·59	—	—	0·37	—	—
28	—	—	—	—	0·98	—	0·29	—	—	—	—	—
29	—	—	—	—	0·52	—	0·07	—	—	0·85	—	—
30	—	—	—	0·14	—	0·59	—	—	—	—	—	—
31	—	—	—	—	—	0·02	1·23	—	—	—	—	—
Total ...	2·07	0·06	2·56	1·49	6·68	6·04	5·75	1·22	4·10	3·35	2·58	2·01

Total rainfall for year, 37·91 inches.

PROGRAMME OF WORK FOR 1940-41.

Cotton.

Cotton Breeding.– Further work on the breeding of U.4 strains for local conditions will be cut down severely. It will be limited to the maintenance of the seed stock of the most important types and the testing of these types in one variety trial.

Work will continue on the crosses between U.4 and Cambodia, now in their third generation, and on the U.4×MU.8A made last year, the main object being to obtain greater hairiness on a good U.4 type of plant and consequent increased resistance to jassid and *Lygus*.

A separate set of crosses will be started to explore the possibility of combining high quality lint with the many good characters of U.4. Two American types of good quality lint, strains of Acala Rogers and Coker Wilds, have been obtained as parents for this purpose. In addition, crosses between U.4 and both Sea Island and Egyptian have been made, though genetic difficulties here are likely to be greater.

Compost Experiment.—This will be continued and will carry cotton this season.

Crop Production and Loss Experiment.—It will be impossible to carry this out fully, but it is hoped to make some simple records bearing on the subject.

Rotation Experiment.—This will be continued for one year to complete 8 full years.

Nitrogen Experiment. –Applications of nitrogen will be made at different stages of the plant's development. As far as possible, records will be made to determine their effect through the season on crop production and also on the nitrogen balance in the plant.

Rotation Crops.

No experimental work will be carried out, but bulks of streak-resistant maize, already obtained from the breeding work, will be multiplied and rogued if necessary.

ROTATION CROPS

BY

M. F. ROSE.

GENERAL.

The season started with a good supply of soil moisture and excellent stands of all crops were obtained over the Station. The drought in February and early March did little damage to the early-planted crops, which yielded well, but caused some anxiety for the late-planted maize breeding material and reduced the yields of soya beans.

MAIZE.

Stalk borer was very prevalent in the district on early plantings, but the Station escaped with a light infestation which did not affect final yields appreciably. The early plantings were also damaged by locusts, but recovered well and gave good yields, though not so high as those recorded in the previous season. The mean yield for the whole season was higher, however, owing to the very light streak infection on the later plantings. Thus, the bulk Hickory plantings of October 23rd and December 1st yielded 2,500 lb. and 2,100 lb. of grain per acre respectively.

Breeding for Streak-resistance.—The objects of this work—within-line improvement in Peruvian and Hickory and the transfer of the great resistance of Peruvian to the more desirable type of plant and grain of Hickory—were discussed in the previous report.

The course of streak infection in all bulk plantings was followed and the records showed a mugh lighter infection than in the previous season. Thus, early-planted American White Flint, at nine weeks from planting, showed only 22% infection against 51% for similar material the year before. Similarly, the same susceptible variety, interplanted with the breeding material to build up a highly infective vector population, developed infection in only 85% of the plants as compared with 98% in the previous season.

The breeding material, planted in good conditions on December 13th and 14th, comprised the following lots:—(1) 43 selfed lines of Peruvian. (2) 9 selfed lines of Hickory. (3) 31 F_1's of Peruvian × Hickory. (4) 8 F_1's of intra-Hickory crosses. (5) 22 F_1's of intra-Peruvian crosses. (6) 16 F_3 lots (white flats) from the original P × H cross made in 1936–37.

Figures obtained from infection counts made on the above lots on February 14th, at nine weeks from planting, are given in the table below.

STREAK COUNTS.

PERCENTAGES OF PLANTS SHOWING DIFFERENT DEGREES OF INFECTION.

Strain.	*Nil.*	*Light.*	*Medium.*	*Heavy.*	*Plants counted.*
Hickory Bulk	18·8	35·4	25·0	20·6	499
Hickory Strains	88·7	10·1	0·6	0·6	324
Intra-Hickory Crosses ...	86·7	10·6	2·1	0·6	413
Peruvian Bulk...	87·9	9·6	1·6	0·6	591
Peruvian Strains	99·8	0·2	—	—	2,740
Intra-Peruvian Crosses ...	99·7	0·3	—	—	1,519
F_1 P×H	98·2	1·8	—	—	2,240
F_3 P×H (White Flats) ...	92·3	5·8	1·3	0·6	1,059
A.W. Flint	15·1	23·2	25·8	35·8	491

Since the infection was lighter, the material was not tested so thoroughly as in the previous season, but as far as can be judged, resistance was well maintained. Little discarding could be done and all selfed lines were maintained. The intra-crosses, of both Peruvian and Hickory, were combined to give double-cross seed and the P×H F_1's were selfed to give the segregating yellow and white seed types in F_2. The best F_3 white flat types, from the original P×H, were selfed and mixed for planting as a bulk in the coming season. In all combinations between selfed lines, both intra- and inter-variety, the ability to form crosses was good and showed no variation between different pairs. Hybrid vigour was fully restored and with it normal cob size.

Compost Experiments.—In the previous season an experiment was started to test the effect of compost in building up the fertility of poor land, both granite and red loam soils. The results from the first season's application on cotton are given in last year's report (p. 16). The dressings, 7 tons and 3½ tons per acre of compost against nil, were repeated on the same plots this season with maize as the crop. The results are given in the following table.

EFFECT OF COMPOST, SECOND YEAR'S DRESSING, ON MAIZE.

Treatment.	*Weight per Plant, Gms.*				*Final Yield, Grain, lb. per acre.*	
	Granite 25 Days.		*Loam 21 Days.*			
	Green.	*Dry.*	*Green.*	*Dry.*	*Granite.*	*Loam.*
Control	12·36	2·03	2·93	0·47	1850	1658
3½ Tons	14·63	2·36	3·65	0·55	2128	2039
7 ,, ...	15·23	2·41	4·54	0·66	2581	2255
Difference for P=·05	2·05	not signif.	0·61	0·08	286	312

It will be seen that for both soils the treatment produced a markedly beneficial effect on both early growth and final yield, the heavier dressing producing a greater effect.

Stooking and Picking Experiment.—The object of this experiment was to ascertain at what stage in the ripening of the maize crop a

farmer could remove it without serious loss of yield. Such removal might be by picking cobs from the plant, or cutting and stooking the crop and allowing the cobs to mature on the stooked plants. Either method of removing the crops allows the land to be ploughed early, before all moisture has dried out of it. This was a repetition of a previous experiment described in the report for 1937–38. Apart from the exclusion of the two earliest dates of harvesting, which were obviously too early to be of practical interest, the experiment was essentially the same. Each treatment comprised 65–70 plants, a 12·5% sample of the block, and there were 20 repetitions.

The results are given in the table below, where all weights are reduced to the same dry basis of 12% moisture content.

TYPE HICKORY. PLANTED 8/11/39. FREE TASSELLING 13/1/40.

Treatment.	*Days from peak of Tasselling.*	*Condition of Grain.*	*Yield per Plant, lb.*	*Yield as % Normal.*	*Seed weight Gms. per 100.*
Picking	53	Medium cheese stage	·302	69·7	49·4
Stooking			·360	83·3	57·2
Picking	60	Hard cheese stage	·351	81·2	54·2
Stooking			·390	90·2	60·9
Normal	75	Fully ripe	·433	100·0	64·1
Difference for P=·05			·011	2·5	1·2

It is obvious that the grain has derived considerable benefit from the haulms whilst in the stook, a benefit that decreases with increasing maturity of the plant. It is rather surprising that the earlier stooking has actually given a higher yield and seed weight than the picking of a week later. These results are in general agreement with those of the 1937–38 experiment in showing the advantage of stooking over picking when the crop is not fully ripe.

The two experiments are not in agreement as regards the other issue, the stage at which stooking can be carried out without loss of crop. In the earlier experiment the conditions had been very dry for some time before the crop ripened, whereas in this season there was no serious lack of moisture. The drier conditions foreshortened development, hastened ripening and gave a lighter seed-weight, thus reducing the loss resulting from premature harvesting. In the present season, stooking when the grain was in the "hard cheese" stage, which was expected to be about right, resulted in a loss of 9·8% of the yield. It is clearly necessary to take account of the condition of the plant and the state of soil moisture, in addition to the condition of the grain on the cob, when deciding the stage at which it is safe to stook the crop.

Stored Seed Maize. Effect of Treatment for Insect Control.—In the 1937–38 Report the results of a preliminary experiment were recorded

in which the use of sodium fluoride as an insecticide for seed maize had adversely affected germination and early growth of the plant. A further experiment has now been carried out with various treatments to compare their effects—(*a*) in controlling insects (1) and (*b*) on germination and subsequent plant development.

On July 3rd, 1939, Hickory maize seed (white flat) of 14% moisture content was subjected to the treatments detailed below. In each case 100 lb. of seed was treated and then stored in a steel drum till the time of planting, November 17th, a period of 137 days. Samples for estimating insect damage were withdrawn after 116 days.

(1) Control; sun-dried for 3 days and covered with a layer of fine sand.
(2) Carbon bisulphide, 6 lb. per 1,000 c. ft., fumigated for 24 hours at monthly intervals.
(3) Carbon bisulphide as above but 18 lb. per 1,000 c. ft.
(4) Sodium fluoride, 1 : 1,000 by weight, well mixed.
(5) Sodium fluoride, 2 : 1,000 by weight, well mixed.
(6) Drymac No. 2 (2), 1 : 1,000 by weight, well mixed.
(7) Drymac No. 2 (2), 2 : 1,000 by weight, well mixed.

The results of the experiment are given in the table that follows.

MAIZE SEED TREATMENT.

Treatment.	*% Seed undamaged by Insects.*	*Germination.*			*Dry wt. gms. per Plant, 21 days.*	*Final Yield Grain, lb. per acre.*
		% 6 days.	*% 19 days.*	*6 days as % Final.*		
Control	45·5	39·2	58·8	66·6	1·01	2,184
CS_2 (6 lb.)	84·0	53·8	82·2	65·5	1·37	2,654
CS_2 (18 lb.)	84·1	42·2	82·1	51·4	1·25	2,373
Drymac × 1	57·3	46·4	67·3	68·9	1·19	2,384
Drymac × 2	71·5	51·0	78·1	65·3	1·34	2,337
NaF × 1	78·1	10·0	60·6	16·5	0·76	1,871
NaF × 2	67·8	8·9	52·2	17·0	0·80	1,782
Difference for P = ·05 ...	5·8	4·1	3·9		0·20	249

It will be seen that CS_2 at 6 lb. per 1,000 c. ft., the normal dosage, has given good protection in addition to stimulating early growth. The 18-lb. dose has given no better protection, but has retarded germination, although early growth is still better than Control. The double dose of Drymac is better than the single as regards both protection and early growth, but falls a little behind the CS_2 at 6 lb. in general effectiveness. A heavier dressing might be better. The NaF treatment is clearly most unsatisfactory: whilst giving fair protection it has very seriously retarded germination and early growth, and the yield has suffered considerably.

MISCELLANEOUS CROPS.

Sunflowers, St 3, the strain of the striped variety grown on the Station, was planted on the rotation plots and gave a good yield of 1,635 lb. per acre. Mass selection was carried out in the above strain and in two types of black, for maintaining the seed supply.

(1) Mainly spp. of *Calandra*, *Sitotroga* and *Ephestia*.
(2) A derris compound, kindly supplied by Cooper and Nephews Ltd., Johannesburg.

Soya Beans felt the effect of the drought during their fruiting period and gave a poor yield of 755 lb. per acre. *Tepary beans*, which had developed their crop earlier, gave a fair yield of 1,063 lb. per acre.

Sunn hemp was grown on several fields on both types of soil for composting purposes. The crop started very well but a wilt disease, identified by Dr. Wickens as *Fusarium sp.*, made its appearance at the end of December. The crop on the granite soil was very badly affected; the attack on the loam was rather later and less severe, though still causing appreciable damage. This is the first experience of a heavy attack of wilt on the Station.

SUMMARY.

Maize.—Streak disease developed more slowly than usual and good yields were obtained from late-planted Hickory. Breeding for resistance to this disease was continued and the material—strains and crosses of Peruvian and Hickory—appeared to be maintaining a high degree of resistance. Both the intra- and inter-varietal crosses of these two parents have given very promising types.

A second season's application of compost gave a marked beneficial effect on early growth and yield of maize on both granite and poor loam soils.

A stooking and picking experiment confirmed previous results indicating that immature grain derives great benefit from the haulms whilst in the stook. The stage at which an immature crop can be stooked without loss of yield appears to vary with the conditions of the season.

In a seed-treatment experiment, fumigation of maize seed with CS_2 at 6 lb. per 1,000 c. ft. gave the best results—protection from insects, germination and later growth all being good. NaF delayed germination and retarded growth. Drymac No. 2 was moderately satisfactory.

Miscellaneous.—Good crops were obtained from sunflower and tepary beans, but soya beans were damaged by drought. Sunn hemp suffered severely from a *Fusarium* wilt.

WITCHWEED.

Striga asiatica (L), D. Kuntze, (= *S. lutea*, Lour.).

Foreword

BY

F. R. PARNELL.

Mr. Rose, who has had this work in hand, is now on military service and is unlikely to be able to continue it in the near future. As his results to date, though very incomplete, are of considerable importance, it is desirable that they should be placed on record in some detail. I have, therefore, put them together on his behalf. The opportunity is taken to record some early results obtained by Mr. Lochrie, which led up to this work.

Report on Laboratory Germination of Seed carried out by M. F. ROSE, with some Preliminary Results by J. V. LOCHRIE.

Introduction.

This species of witchweed is parasitic on many species of the Gramineæ and causes serious damage to gramineous crops in some of the summer rainfall areas of South Africa. It is particularly prevalent in the hotter regions, where cotton can be grown, where it is a serious deterrent to arable farming and hence to the development of cotton-growing. Its control offers considerable difficulty, since the seed may lie dormant in the soil for many years in the absence of a host plant capable of activating its germination. Many workers have stated that the seed germinates only in the presence of a suitable gramineous host and Saunders (1), who investigated the problem in South Africa, arrived at the same conclusion and showed that an activating substance was excreted by the roots of the host plant.

Lochrie's Early Results.

Rotation Plots.—Doubts were thrown on the above conclusion by some results obtained by Lochrie at Bremersdorp. In working with a rotation experiment on witchweed-infested land he found, as might be expected, that a crop of maize in which the witchweed plants were hand pulled was very effective in reducing the infestation. Quite unexpectedly, however, certain non-gramineous crops also appeared to have reduced the infestation.

Six rotational treatments occupied a randomized block lay-out, each with four replications of one-fiftieth-acre plots. Maize was planted over the whole area in the following year and the *Striga* plants that

(1) Saunders, A. R., "Studies in Phanerogamic Parasitism," Sc. Bull. 128, Dept. Agr., Union of South Africa, 1933.

appeared were pulled out and counted for each plot separately. The treatments and figures are given below.

Treatment, 1931–32	*Mean Nos. of Striga Plants per plot on Maize* 1932–33.
Maize (*Striga* pulled)	361
Groundnuts	372
Sugar Beans, *Phaseolus vulgaris*	910
Sunnhemp, (ploughed in)	953
Buckwheat, *Fagopyrum esculentum* (ploughed in)	2,797
Bare Fallow	3,318

Difference for P = ·05 = 1,871

Considerable irregularlity in the figures is unavoidable in dealing with land naturally infested with witchweed seed, but, in spite of the large error, very significant differences appeared. There was good reason for suspecting that Groundnuts, Sugar Beans and Sunnhemp had actually destroyed much of the *Striga* seed by causing it to germinate : having germinated it would die, without appearing above the surface, through lack of a host plant on which to develop.

Germination of Seed.—Following the above results, attempts were made to germinate *Striga asiatica* seed on a number of crops. The seed was sown on moist filter paper, placed between glass slides and buried in the soil of pots carrying freshly-germinated hosts of various species. Before sowing the hosts, the soil in the pots had been watered and weeded to prevent any interference by adventitious weeds. Four slides were used for each host and they were removed and examined at intervals to record germination.

More than 75% of the *Striga* seed disintegrated during the test, presumably as a result of immaturity, hence actual percentage germination counts were not made.

Maize.—Germination had started at 14 days and was general at 4 weeks, though varying markedly for different slides. This treatment gave the highest and earliest germination.

Kaffir Corn.—Very similar but slightly later.

Sunnhemp.—Total germination little less than with maize though slightly later.

Groundnuts and Sugar Beans.—Similar results, approximating to those for sunnhemp. One slide of each equalled the best maize slide in germination.

Cotton.—Very variable, one slide high germination, but averaging less than previous hosts and germination later.

Bulrush Millet (*Pennisetum typhoideum*).—Germination delayed and less than all other hosts. There appeared to be less " disintegration " of *Striga* seed here.

Bare Fallow.—No germination.

The above results substantiated those from the rotation experiment and it seemed evident that the generally accepted conclusion, that

Striga asiatica seed needs a gramineous host to activate its germination, would have to be revised. Further work was required, however, to clear up two points on which doubts might arise :—(*a*) Was there a possibility of a small admixture in the seed of another species of *Striga*, taken inadvertently with *S. asiatica?* (*b*) Was the seed that germinated under non-gramineous hosts fully matured ?

It was impossible for Lochrie to continue the work at Bremersdorp and his results were followed up by Rose working at Barberton.

Rose's Laboratory Work.

Seed.—Only one species of *Striga* is to be found in maize and sorghum fields in the Barberton locality, and 20 plants, covering the full range shown, were all identified as *S. asiatica* (L), D. Kuntze, (=*S. lutea*, Lour.) by Dr. E. P. Phillips, Chief of the Division of Botany and Plant Pathology, Pretoria. The seed used throughout the experiments was one bulk collected from patches of this species in a maize field. It was a very good well-filled sample and was about 9 months old when the experiments started.

Method.—The method employed was one of several used by Saunders (l.c.). Large test tubes, $1\frac{1}{4}'' \times 7''$, were used for growing the host plants. Witchweed seeds, from 100 to 200, were sown on a strip of damp blotting paper which was then inserted in the tube and applied to the side, the seed lying between the paper and the glass. A fragment of cotton wool was placed over the drainage hole, the tube filled with dry sand and seeds of the host planted in it and watered. Germination of the *Striga* seed was noted at intervals by examination *in situ* through a microscope.

White blotting paper is a poor background for showing up the primary rootlets of germinated seed and ordinary green blotting paper was finally adopted as most satisfactory. This was washed in running water for 48 hours to remove free dye before use.

The sand used was sunned for 5 days and sieved through mosquito gauze, but not washed or sterilized. Tap water, a very soft river water, was used throughout for watering. Of the larger hosts, 3 seeds were planted in each tube, of the grasses a greater number. The tubes were kept dark in racks surrounded with black cloth, but the host seedlings were exposed to the light of the laboratory.

Experiment 1.—Tubes were arranged in two series one above the other, about $\frac{1}{4}$ inch apart. The upper series was planted to various hosts, 4 tubes to each ; the lower, labelled " D " in Table I, received only the drainage percolating from those above at each watering.

The " host " tubes were planted on December 15th, 1939, and the

final *Striga* germination counts were taken after 27 days, for which period the laboratory temperatures had been—Mean Max. 84·8° F., Mean Min. 74·8° F. The " drainage " tubes were started 8 days later, when the hosts had germinated well, and counts were made at 33 days, the mean temperatures for this period being about 1° lower. The results are given in Table I.

TABLE I.

Host.	*Percentage Germination of Striga Seed.*				
	1	2	3	4	*Mean.*
Colonial Sudan Grass (*Sorghum sudanensis*)	89·4	31·8	23·6	4·7	37·4
Do. D.	4·3	0	2·8	2·0	2·3
Kaffir Corn, *Sorghum vulgare*	77·2	46·8	25·3	21·3	42·7
Do. D.	2·3	0	5·6	6·0	3·5
Amber Cane, *Sorghum vulgare*	15·4	0	7·1	Discard	7·5
Do. D.	0	2·4	1·0	0	0·85
Maize, *Zea mays*	42·6	3·7	3·2	Discard	16·5
Do. D.	0	0	1·1	1·1	0·55
Teff Grass, *Eragrostis abyssinica*	4·0	2·0	0	0	1·5
Do. D.	0	0	1·2	1·9	0·77
Groundnuts, *Arachis hypogea*	0	0	0	0	0
Do. D.	1·9	1·7	0	0	0·9
Nil	0	0	0	0	0
Do.	0	0	0	0	0

The gramineous hosts all gave some *Striga* germination, the amount undoubtedly varying with the species, but showing great irregularity for one species. It should be noted that the teff seedlings made extremely little growth and died off rapidly, which probably accounts for their poor showing. In all other cases the seedlings made reasonable growth and survived to the end and there appeared to be no relation between the condition of the host seedlings and the percentage of *Striga* germination for any one species.

The " drainage " tubes showed very much lower germination, again very variable, and bearing no relation to that of the " host " tube above. In view of their poor showing, drainage tubes were not used in later experiments.

Groundnuts, the only non-gramineous species, gave no germination in the " host " tubes, but a small percentage in two of the drainage tubes. Later results indicate that this was probably a true " activation " effect.

Experiment II.—" Host " tubes planted January 16th, 1940; germination counts after 28 days; temperatures, Mean Max. 83·0° F., Mean Min. 73·3° F.

TABLE II.

Host.	*Percentage Germination of Striga Seed.*			
	1	2	3	*Mean.*
Colonial Sudan Grass	46·8	58·1	76·6	60·5
Amber Cane...	77·0	50·0	15·8	47·6
Sunflower	14·3	15·0	9·0	12·8
Sunnhemp, *Crotolaria juncea*	1·0	0	0	0·3
Dolichos Bean, *D. lablab*	0	2·0	0	0·7
Nil	0	0	0	0

The most striking result here is that the non-gramineous sunflower has given very appreciable germination in each tube. This was a perfectly normal germination, with well-defined primary rootlets. The small amount of germination under sunnhemp and dolichos is less noteworthy.

It will be noticed that amber cane has given a much higher percentage germination than in the previous experiment, and Sudan grass is more regularly high.

Experiment III.—"Host" tubes planted February 27th, 1940; germination counts after 29 days; temperatures, Mean Max. 82·9° F., Mean Min. 73·9° F.

TABLE III.

Host.	*Percentage Germination of Striga Seed.*			
	1	2	3	*Mean.*
Colonial Sudan Grass	70·0	16·3	4·5	30·3
Groundnuts	33·1	10·4	30·8	24·8
Cotton, *G. hirsutum*	37·4	0	0	12·5
Tepary Bean, *Phaseolus acutifolius*	0	0	0	0
Nil	0	0	0	0

Again it is seen that a non-gramineous host can activate germination, groundnuts proving very effective in all three tubes and cotton giving a high figure in one tube. As in the case of sunflower, well-defined rootlets were formed.

Experiment IV.—A trial was made with larger tubes, lamp glasses of $1\frac{3}{4}'' \times 13''$, to give better development of the host plants, and in half the glasses a rich potting soil replaced the sand. The hosts in sand grew no better here than in the smaller test tubes, however, and the potting soil (2 loam, 2 compost, $\frac{1}{4}$ sand, $\frac{1}{4}$ plant ash) was far too rich and gave poorer growth.

Temperatures were lower, Mean Max. 78·4° F., Mean Min. 70·2° F., and counts made at 23 days showed low and irregular figures for *Striga* germination in sand and nothing whatever in potting soil. It was noted that germination occurred only in the upper half of the glasses.

The whole batch was removed to a glass house giving a much higher daytime temperature and examined again after 10 days, Mean Max. 96° F., Mean Min. 69° F. Much of the *Striga* seed that had not previously germinated, under various hosts and also in some of the controls, had burst at the micropylar end and showed a slight extrusion of tissue. This was not looked upon as true germination and all but the controls were discarded. The latter were again examined, after a further 15 days in the glass house, and the splitting had developed into a definite germination. The germination percentages were as follows:—

No host, sand, (*a*) 19·6% (347 seeds counted).
No host, sand, (*b*) 0.
No host, soil, (*a*) 11·2% (292 seeds counted).
No host, soil, (*b*) 0.

The rootlets in sand were quite normal and well developed, 0·46 mm. in mean length, that is slightly longer than the seed itself. In potting soil they were smaller, 0·13 mm. in mean length, and less well defined.

This experiment proves beyond doubt that *Striga asiatica* seed can germinate without a host in certain conditions. It may be noted that the actual period taken for germination was made up as follows :—

23 days, Mean Max. 78·4° F., Mean Min. 70·2° F.
10 days, Mean Max. 96° F., Mean Min. 69° F.
15 days (approx.) 96° F., Mean Min. 69° F.

There is a possibility that the wide daily range in temperature to which the seed was subjected during the latter half of this period, or merely the high maxima, may have been instrumental in bringing about this germination.

DISCUSSION.

It will be noticed from the figures in Tables I—III that the results are very irregular. Thus, Sudan grass, Table I, varies from 4·7%–89·4%, and in Table III from 4·5%–70·0% ; groundnuts gave no germination in Table I, but 10·4%–33·1% in Table III ; cotton, Table III, two tubes with 0 and one with 37·4%. It is obvious that some important controlling factor has been subject to variation, not only between experiments but also between similarly treated tubes in one experiment.

The *Striga* seed, sand and water were the same throughout ; temperatures were uniform in any one experiment and practically the same for all three. Variation in activating power of individual host plants (of the same species) could be a factor, but does not appear to be a likely one. Watering was in regular amounts, but the actual degree of saturation of the sand, and with that the degree of aeration, may have varied according to the amount of transpiration by the host seedlings, freedom of drainage, etc. Another possible cause of variation, which appears very probable, is that the host roots may have been very differently distributed in the tubes, so that their proximity to the *Striga* seeds may have varied greatly from tube to tube. (The seeds occupied only a narrow strip down one side.) A sloping tube, with the strip of blotting paper down the lower side, might bring the roots more regularly into contact with the paper.

Further work is required to elucidate such points and to devise methods that will give consistent results. The fact that such irregularities have arisen is sufficient indication that very exact control

of the conditions is necessary to avoid the risk of drawing erroneous conclusions. A host giving negative results with a certain technique might give very definite positive results in slightly modified conditions.

The general issue is complicated by the fact that, in the special conditions of Experiment IV, a considerable percentage of *Striga* seed germinated, in two tubes out of four, in the absence of any host. It is of importance to note that, so far as can be judged, similar conditions might quite well occur in the field.

In spite of this there can be no doubt that, in Experiments I–III, some of the hosts stimulated germination that would not have taken place in their absence. Thus all 10 control tubes with no host gave no germination, whereas 20 tubes containing the three sorghums, in spite of much variation, gave only one negative result and a mean figure of 37·9% germination. This is in accordance with the results of previous workers, who have shown the activating effect of many species of gramineous hosts. In addition, however, substantial germination was obtained in these experiments with certain non-gramineous hosts, *e.g.*, sunflower, all 3 tubes positive, mean 12·8% ; groundnuts, 3 out of 7 tubes positive, mean 10·6% ; cotton, 1 out of 3 tubes positive, mean 12·5%. These three hosts give a combined figure of 7 positive results from 13 tubes, with a mean of 11·5% germination. There is no reason for doubting that they exerted the same type of activating effect as that of the gramineous hosts.

To these non-gramineous activators must also be added sugar beans and sunhemp on Lochrie's evidence, in spite of the fact that the latter gave poor results in Rose's Experiment II.

Much more work on this problem is required, since it is evidently far less simple than has been generally believed. All experience indicates that in the field *S. asiatica* makes no effective growth on non-gramineous hosts, hence such a host that activated germination of the seed would be of great value in the practical control of the parasite. Thus, Lochrie's observations on the effect of groundnut, sugar bean and sunnhemp rotation plots appear to afford an example of such action. Can the beneficial effect of cotton on a succeeding maize crop, reported from many centres, be partly due to similar action ?

Summary.

Seed of *Striga asiatica* (L), O. Kuntze, (=*S. lutea*, Lour.) was successfully germinated under several gramineous hosts and also under sunflower, groundnuts and cotton, which appeared to exert the same activating effect as the gramineous species. Early experiments also gave good germination under sugar beans and sunnhemp.

Striga seed gave substantial germination in the absence of any host after 48 days, during the last 25 days of which it was subjected to a wide daily range in temperature with high maxima.

Irregular results indicated the failure to control some important factor, possibly the proximity of the host roots to the *Striga* seed.

Generally accepted ideas regarding the practical control of *Striga asiatica* will undoubtedly require revision when the full story is available.

PHYSIOLOGICAL WORK.

PROGRESS REPORT, 1939–40

BY

R. C. RAINEY

Work was suspended in June, 1940, when the writer went on military service. While to a considerable extent the results of the last 2½ years may be regarded as complete in themselves, it is thought that they also indicate clearly the most fruitful line of approach for further work of this nature—namely, a study of the physiological relationships between the cotton plant and the pests and diseases attacking it, with particular reference to existing and potential resistant varieties.

THE DEVELOPING BOLL.

Chemical Changes.—Biochemical work has been continued on the boll material collected last season and described in the previous report. A series of estimations of total nitrogen has been completed on the samples from the second planting, which gave the better crop, and a number of duplicate determinations of oil have also been made on this material.

Material was also obtained from one of Wickens' series of periodic plant withdrawals, representing healthy bolls of known age and position collected on a number of successive occasions. This was intended for use in investigating the extent to which the results already obtained, on the changes in composition of bolls developing from flowers produced on one particular day, could be applied to the whole crop. While nothing further than dry weight determinations was actually carried out on this material, the results gave growth rates which were substantially similar for all bolls set during the first six weeks of flowering, accounting for practically the whole of the crop. Further, close agreement was shown with the growth rates recorded for the material used in last season's analytical work. This season's material was obtained from somewhat poorly grown plants, which suffered

considerably from premature leaf fall. This may account for the lower growth-rates found for the few bolls set later than six weeks from the start of flowering. Thus, so far as they go, the results may be regarded as indirect evidence that the outline of the biochemistry of boll development given below is in fact applicable to the greater part of the crop.

During the last season determinations of oligosaccharides (sucrose and raffinose) (1) were made at the same time as those previously reported for reducing sugars. It was not found possible to check the method used at the time, but this has now been done by investigating the recovery of known amounts of oligosaccharides added to fresh material before extraction by the method previously developed. Within the limits of experimental error completely quantitative recovery of the added sugars was obtained, with no indication of hydrolysis during the process of extraction. The oligosaccharide results are accordingly included in Table I, which summarizes the information so far obtained on boll development.

TABLE I.

GROWTH IN THE COTTON BOLL.

Weights per boll of constituents of developing ovules, variety 052, *planted* 7/12/38; 1,500 *flowers tagged* 1/3/39, *and samples withdrawn at weekly intervals.*

Age *Weeks.*	*Water.* *gms.*	*Reducing sugars.* *mg.*	*Oligo-saccharides.* *mg.*	*Protein.* *mg.*	*Oil.* *mg.*	*Remaining dry matter.* *mg.*
Flowering	0·025	0·27	0·23	2·4	0·009	3·1
1	0·614	35·1	5·4	15·0	—	20
2	4·17	236	40·0	57·2	6·5	180
3	8·05	463	75·3	145	—	405
4	10·13	433	107	206	16·0	883
5	10·41	339	—	275	76·5	1,445
6	8·67	229	161	329	234	2,147
7	8·47	196	193	420	379	2,627
8	7·92	163	142	623	—	3,171
9	6·99	88·2	122	676	—	3,640
Splitting 10	2–5	30	121	629	568	3,171
Sig. diff. 2–10 weeks incl. (P=0·05)	0·59 (2–9 wks.)	41	31	44		

A full discussion of the data from the physiological and biochemical standpoints has not so far been attempted, but two main phases of boll development, of roughly equal duration, are readily distinguished. The first is characterized by rapid growth in size and by high water and reducing sugar contents; during the second, no further growth in size occurs, but the preliminary "scaffolding" of sugar and water is almost completely replaced by the constituents of the mature boll—protein, oil and, of course, cellulose. Thus the total fresh weight of the

(1) An attempt to estimate these two sugars separately was unsuccessful; local samples of top and bottom yeasts (kindly supplied by the Castle Brewery, Johannesburg), failed to yield enzyme preparations which differed sufficiently in melibase activity for this purpose. The physiological roles of the two sugars are probably quite different; sucrose is stated to be the form in which carbohydrate enters the boll, and raffinose is probably entirely a reserve material.

developing ovules (²) shows no further increase after five weeks, but 86% of the oil, 56% of the final protein, and 54% of the remaining dry matter (mainly cellulose) are laid down after this. The steady uptake of nitrogen over a period of at least two months is also of interest, for example, in connection with the choice of nitrogenous fertilizers for top dressing.

Following the qualitative demonstration of the presence of tannins in the developing boll last season, a start has been made on quantitative work. Comparative trials of the Lowenthal oxidimetric and the Mitchell colorimetric methods have been carried out, but, owing to the ill-defined nature of the tannins, standardisation has presented some difficulty. A preliminary attempt has been made at isolating the tannin for this purpose, as well as for investigating its effects on insect and fungus nutrition. A small amount of a pink precipitate, presumably the tannin, was obtained by salting out an aqueous extract of boll material, but time has not permitted the further purification of this preparation. The results so far attained are accordingly expressed in terms of gallotannin (Table II); it will be noted that the boll tannin appears to have a much greater tinctogenic activity in proportion to its oxidising properties than has gallotannin. The tinctogenic substance was found to be completely precipitated by quinine hydrochloride; gallic acid and similar simple phenolic compounds giving the colour reaction are thus absent.

TABLE II.

TANNINS IN OVULE MATERIAL.

(Expressed as gallotannin % fresh weight.)

Var.	*Age.*	*Oxidimetric method.*	*Colorimeter method.*
U/4–5143	5 weeks	0·36%	1·3%
U/4–5143 and 6128	8½ ,,	0·24%	1·1%
Cambodia–9363	8½ ,,	0·20%	1·1%

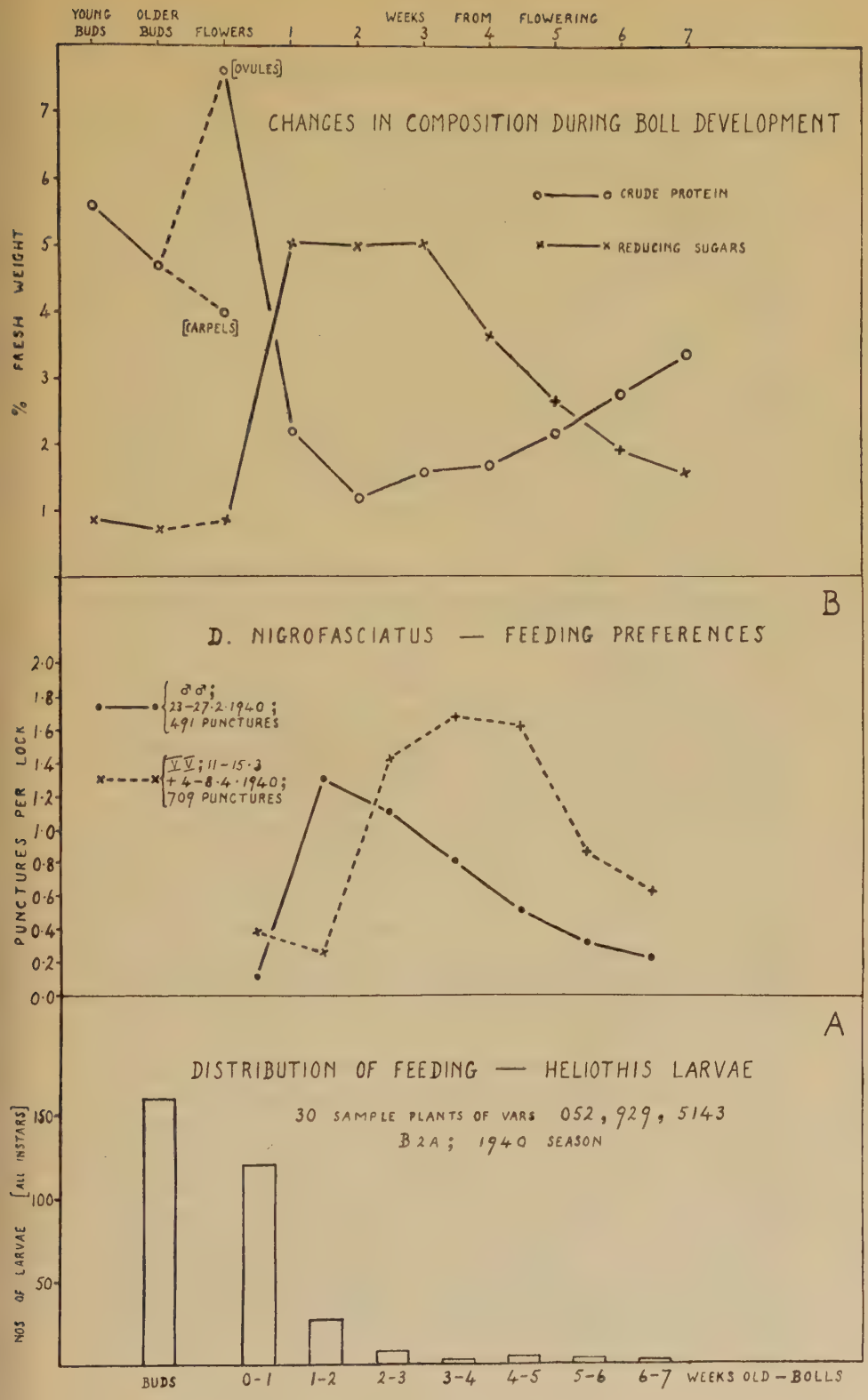
Susceptibility to Insect and Fungus Attack.—As indicated in the previous report, one object of this work was to throw light on factors influencing the changes in susceptibility to insect and fungus attack which occur in the course of boll development, in the hope that similar factors might also be concerned in actual or potential differences between varieties in this respect. In this connection it may be mentioned that the results of preliminary field trials, reported below, do in fact show differences in pest incidence which may foreshadow varietal differences in susceptibility to stainer and to red bollworm. Attention is accordingly directed to some indications of the role of biochemical factors suggested by the results of this work. It must be emphasized that while these results may suggest such relationships they do not,

(²) The carpels also show no further increase, even in dry weight, after 5 weeks.

of course, prove their existence. The interest of such results lies in the suggestions they afford as to profitable lines of work for precise experimentation on the nutrition of the pests concerned.

Total sugars are at a maximum between one and three weeks, which, as previously pointed out, was shown by Pearson to be the stage most susceptible to *Nematospora* ; sugars, particularly glucose, fructose, mannose, and maltose, have been shown to be the most suitable energy source for the fungus (Farries and Bell, 1930). M. Steyaert, of the Bambesa Cotton Research Station in the Belgian Congo (who visited Barberton in May) has also worked on this point, less intensively but more extensively, and his observations agree substantially with the present ones. He has also demonstrated significant differences in reducing sugars in 23-day-old bolls between a number of locally selected pedigree lines of Triumph Big Boll, together with significant differences between these lines in susceptibility to *Nematospora*, as assessed by the size of lesions produced by standard inocula in cut bolls of the same age. These preliminary results gave no correlation between sugars and susceptibility, but M. Steyaert agrees that further work, especially on the measurement of susceptibility, is necessary before a final pronouncement can be made on the point. An indication of a similar possible relationship between composition and insect attack is afforded by the fact that the American bollworm larva shows a strong preference for the younger parts of the plant in which the protein content is highest. This is illustrated by Fig. 1, A, based on the data on the distribution of bollworm feeding sites recently obtained by Parsons and Marshall. A point of interest in this connection is that, as previously reported, differences in nutritive value between food crops also appear to account for observed differences in the mortality rates of larvæ reared on different diets. Such pupæ as are produced on the poorer diets are particularly characterized by low figures for solids-not-fat, and crude protein has been found to account for over 80% of this fraction.

Field caging experiments carried on this season have supplied data on stainer feeding sites similar to those previously cited for *Heliothis*. The method used was to enclose stainers in large mosquito gauze cages in the field, on well-grown plants on which all bolls had been tagged at flowering and subsequently bagged to protect from insect attack until needed. The plants were exposed to the caged stainers for four days, this period having been suggested by some of Wickens' preliminary results for single stainers caged in the field on individual bolls. The cages were then removed, the stainers collected and counted as a check on escapes, etc., and the plants removed to the laboratory for


YOUNG BUDS
OLDER BUDS
FLOWERS
WEEKS FROM FLOWERING
1
2
3
4
5
6
7
CHANGES IN COMPOSITION DURING BOLL DEVELOPMENT
[OVULES]
[CARPELS]
CRUDE PROTEIN
REDUCING SUGARS
% FRESH WEIGHT
B
D. NIGROFASCIATUS — FEEDING PREFERENCES
♂♂; 23-27·2·1940; 491 PUNCTURES
♀♀; 11-15·3 + 4-8·4·1940; 709 PUNCTURES
PUNCTURES PER LOCK
A
DISTRIBUTION OF FEEDING — HELIOTHIS LARVAE
30 SAMPLE PLANTS OF VARS 052, 929, 5143
B2A; 1940 SEASON
NOS OF LARVAE [ALL INSTARS]
BUDS
0-1
1-2
2-3
3-4
4-5
5-6
6-7
WEEKS OLD — BOLLS

examination. The flowering date and position of each boll were recorded, together with the number of punctures observed in each lock.

The species used was *D. nigrofasciatus*, and attention was concentrated on 5th instar nymphs and on adult males, since it was considered that the food requirements for active growth in the former might differ considerably from the purely maintenance requirements of the latter. All bolls examined were classified into weekly age-groups and a mean figure for punctures per lock calculated for each group.

The results are exemplified by Fig. 1. B. The males show a marked preference for young bolls of high sugar content ; Pearson has shown that a plain sugar solution (artificial nectar) supplies a completely adequate " maintenance-ration " for the adults of this species, and that it is in fact probably the nectar supplied by various flowering trees of the Low Veld during the latter part of the dry season which enables the species to over-winter.

The nymphs appear to select somewhat older bolls, (1) possibly associated with higher protein requirements for growth ; the rejection of still older bolls, despite a further rise in protein, is perhaps connected with the declining water content or the hardening boll-wall.

Caging experiments with 3rd instars gave negligible puncturing ; the younger nymphs apparently feed mainly on split bolls. Such figures as are available for females appear roughly similar to those for 5th instars ; other work has already suggested that available protein is essential for egg development.

The applicability of these caging results to events in the field is indicated by some observations of Wickens' on samples of normal plants withdrawn at intervals for examination. He found an increasingly prominent puncturing maximum in bolls around 4 weeks of age at a time when stainer records showed an increasing preponderance of 5th instars in the population, and also a second maximum of each occasion at about 2½ weeks, possibly due to males.

Varietal Differences in Susceptibility.

Field experiments were laid down in collaboration with Wickens to supply information on the incidence of pests and diseases on a range of U.4 and other types. Eight varieties were included in a randomized block lay-out, and single-row plots were used in order to minimise the effects on pest distribution of cover, which it was thought might otherwise completely swamp the effects of smaller differences of the type

(1) Other data for successive occasions show that no appreciable shift of age preferences occurs over the period concerned ; comparison of the two curves given is thus valid. The difference in age preferences indicated was shown on both occasions on which males and fifths were compared.

sought. As mentioned in this season's programme (1939–40), work of this nature would be greatly facilitated by some objective quantitative measure of cover, for the purpose of eliminating statistically the effects of cover in comparing pest incidence on plants of different habit. A few observations were made for this purpose with a Weston Photronic Photo-electric cell, kindly calibrated by Dr. W. R. G. Atkins, F.R.S., used with a portable micro-ammeter. The results were promising; the apparatus is very convenient for field use, and the problem of obtaining a representative single figure for a particular plant or plot for the "day-light factor" (1) resolves itself into that of developing a satisfactory method of sampling the wide range of values obtainable from point to point within the plant or plot. Spherical uranyl oxalate bulbs might help to overcome this difficulty, by intergrating the light received over a considerable period and from all directions. Another possibility, suggested by Pearson, and on which work had also been planned, was the measurement of cover in terms of its effects on evaporation rate, as measured by the Livingstone atmometer. A possible difficulty here, however, is that during the day time, owing to the effects of convection, atmospheric humidity becomes much more uniform than does light intensity.

The results of these field experiments, so far as growth, yield, stainers and disease are concerned, are left to be dealt with by Wickens in a later report. Reference will be made here only to the results obtained from the bollworm egg records. Two recording plants were chosen at random from each row shortly before flowering started, and twice-weekly collections of *Heliothis* and *Diparopsis* eggs were made by two recorders, each from one of the plants in each row. It was hoped to reduce the anticipated high variance between plants by correlating egg numbers with measurable plant characters such as flower production or yield, but the reduction obtainable in this way proved to be small. A better method for future work would be to use fresh recording plants on each occasion; this would give a much more precise comparison between varieties—at the expense, of course, of the comparison between occasions, which is of secondary interest.

Despite this difficulty of high inter-plant variance, and also that of a generally light oviposition, some interesting results were obtained; in particular, records of *Diparopsis* eggs on the first planting appeared to merit analysis. Differences between varieties, in total eggs, practically reached the 5% level of significance; an actual value of

(1) "The illumination in shaded sites is best expressed, for ecological work, as the 'daylight factor,' namely, the value of the vertical component of the illumination at any spot given as a percentage of the diffuse light in the open."—(Atkins, Poole and Stanbury, 1937.)

2·09 was obtained for F, the value required for P = 0·05 being 2·16. A highly significant correlation, however, appeared between egg numbers and the flower production over the period concerned (2 to 10 weeks after the general flowering peak), and elimination of this variable reduced F to 1·88. This residual effect was largely due to heavier laying on the Bukalasa variety B.P. 50/3, which retained its leaf longest of the strains under test.

Miscellaneous.

Finally, two points may be mentioned in connection with the general stainer records. The first is the continuation of the decline in relative importance of *D. fasciatus* which has been in progress for some years past, probably due to the reduction in the area of ratoon and standover cotton which followed the general decline of cotton-growing locally up till the outbreak of war. This season the species has accounted for less than 2% of the stainer population on the Farm. The second is that determinations of the incidence of parasitism have been made on several collections of adults and 5th instars of *D. nigrofasciatus*. Some 13% of both males and females were found to be attacked by several species of dipterous parasite, of which specimens have been stored for identification. The proportion of 5ths parasitised was considerably lower.

ENTOMOLOGICAL WORK.

BY
F. S. PARSONS AND J. MARSHALL.

INVESTIGATIONS ON THE AMERICAN BOLLWORM.

Field work was confined to a continuation in greater detail of the studies referred to in the Reports since 1936–37 on the course of crop production on cotton in relation to losses from bollworm attack.

Owing to the engagement on military service of the members of staff directly concerned, this work has ceased for the time being. Little reference has previously been made to its nature and the results obtained, they are accordingly reviewed here, as follows :—

The existence of three timing relationships in respect to infestations of cotton by American bollworm had been ascertained, *viz.*:—

(i) The onset of egg-laying in any quantity is signalized by the appearance of flowers or their immediate precursors ; thus a most suitable indicator of the beginning of the infestation of an individual crop is provided.

(ii) The course and duration of the infestation of individual crops are specified approximately by the flowering cycle.

(iii) The period from planting to the appearance of first flowers on cotton varies but little, being ordinarily 68–72 days.

Based on these relationships studies by means of plant diagrams have been made over four successive seasons on the effect on the plant of varying weights of infestation by the two main summer generations of bollworm that occur here. The questions originally asked were— " Where on the plant does the loss of fruit fall, and what relation does the loss of fruit in particular sectors of the plant bear to ultimate yield ?" Prior to the season 1939–40, observations were confined to the 052 strain of U.4. Observations for the past season were extended to include three strains of different habit, as noted later, and covered their reaction in respect to the shedding of damaged and undamaged buds and bolls, the sites and stages of fruit destroyed, sources of ripened bolls, relative importance of fruiting sectors at times of attack, and times and degrees of recovery from attack. Perhaps the main practical objective of this work is that of defining characters of strains which may be associated with ability to recover from attack, and, had opportunity offered, a wide range of material would have been studied in the coming and successive seasons. Concurrently with these observations it was proposed to investigate ecoclimatic relationships, especially effects of cover, for comparisons of incidence on plants of different habit,

and the nutrition value of the food classes sought by larvæ in its possible rôle in causing very high mortalities amongst the larvæ of the second generation due to protein deficiency, as referred to later. Furthermore, as the damage by bollworm alters the course of growth and fruiting, rendering strains differentially susceptible to damage by stainers and boll diseases, concurrent investigations of those subjects were also envisaged.

Results from the 1936–37 season's work were considered to be marred through excessive " handling effect " on the plants. This effect was much reduced in 1937–38 and particularly so in the seasons 1938–39 and 1939–40 by changes in the methods of recording.

As regards results from the 1937–38 work, interest attached mainly to the budding and shedding behaviour of the infested, as compared with the uninfested, plants. Data in this connection are given in Table I, where the letter " M " refers to the monopodial branches, and " S_1," " S_2," etc., to successive upward sympodial branches in groups of 5, these representing a division of the plant into fruiting sectors.

TABLE I.

SECTORIAL ANALYSIS OF BUD, BOLL AND YIELD HISTORY, 1937–38, STRAIN 052.

(In terms of 1 plant means.)

	Buds Formed.	*Buds Shed.*	*Bolls Formed.*	*No. of Bolls giving Yield.*	*Yield in Grammes, Seed Cotton.*
UNINFESTED—					
M	56·2	22·9	33·3	12·4	41·0
S_1	32·8	11·8	21·0	10·7	37·8
S_2	26·0	9·4	16·6	7·1	26·8
S_3	14·6	5·4	9·2	3·2	11·8
S_4	6·9	3·0	3·9	0·9	2·7
TOTAL ...	136·5	52·5	84·0	34·3	120·1
INFESTED—					
M	101·7	60·6	41·1	14·5	41·7
S_1	41·3	21·2	20·1	6·3	21·7
S_2	38·8	21·2	17·6	4·3	12·8
S_3	23·2	12·5	10·7	3·2	8·0
S_4	11·0	5·7	5·3	0·6	1·0
TOTAL ...	216·0	121·2	94·8	28·9	85·2

The above have reference to comparisons in a case where attack by only the first generation was experienced. This attack normally occurs during the early portion of the flowering period, when the flowers and buds are carried mainly on M and S_1. The points of chief interest are the very extensive production of buds following bollworm attack. Sheddings, however, were nearly correspondingly high and the total number of bolls formed in both cases was not widely dissimilar. Finally, of the bolls giving yield there was a small margin in favour of the unattacked plants. But it is evident that these bolls were much heavier, and actually the yield of the unattacked plants exceeded that of the attacked by 41%.

During the season in question there were good growing conditions up to mid-February, and the extra flush of buds on the attacked plants occurred within the period of favourable conditions, but conditions in the following two months were very dry and hot and quite inimical to the requirements of the flushing plants.

The importance of the monopodia as sources of ripened bolls on the attacked plants will be noted. It has long been considered that a plant with a few monopodia is an insurance against losses from bollworm attack and the data in this and subsequent instances go far to confirm that impression.

In the above case the infestation was of moderate extent and there was no second generation attack. It was desired to study the effect of heavy attacks by both generations, separately and following upon each other after the usual interval of time.* The attacks strike the plant at different periods in its fruiting life and their effects require to be studied separately.

In the season 1938–39 plots of cotton were infested by hand at three-daily intervals with insectary-bred larvæ. First-stage larvæ were placed on the plants. The numbers applied on each occasion were based on the hatched fraction of eggs as recorded in the curve of egg-laying on cotton during the heavy layings of 1934. There was a practical absence throughout the season of naturally-bred bollworm so that plots not infested by hand were virtual controls. The results in terms of comparative yields were given in the Report for 1938–39, but they are repeated here below for the sake of continuity.

The plots were reaped in two pickings in order to assess the influences of the attacks of the separate generations. The first picking was taken between the 14th and 30th of April, when the majority of the bolls had opened fully, the second when the remainder were ripe.

TABLE II.

RETURNS IN LB. PER ACRE OF SEED COTTON FROM CONTROL VERSUS INFESTED PLOTS—1938–39.

	1st Picking.	*2nd Picking.*	*Total.*
Control	880	159	1,039
First Infestation only	406	406	812
Second Infestation only...	835	230	1,065
First and Second Infestations	415	535	950

Difference required for significance between pickings at P=·01 is 266. The differences between total yields are not significant by the Z test.

Briefly, the first infestation caused a drop of 50% in the quantity reaped at the first picking, but this was partly made up in returns

* The origin and sequence in calendar time of the summer flights of the American bollworm moth are given in Investigations on the Cotton Bollworm, *Heliothis armigera*, Hubn. Part III. Relationships between Oviposition and the Flowering Curves of Food-Plants, Parsons, *Bull. Ent. Res.*, *Vol.* 31, *Part* 2, *June*, 1940.

from later-set bolls. As stated previously, the buds, flowers and bolls present during the first generation attack are situated mainly on the basal branches The plant diagrams showed again that following the loss of the fruit originally set in the M, S_1 and, partly, S_2 sectors, a large flush of new buds formed, particularly again on the monopodia. Bolls matured from a high proportion of these buds in this season since there was ample soil moisture to the end of the growing period, ripening of them taking place after the first picking. The differences between treatments in the weights of the second pickings were due very largely to bolls set from the reflush of buds following attack by bollworm. In the end, as regards the first infestation treatment, there was no significant difference in total yields between attacked and control plots, although the latter were actually 28% higher.

The second infestation apparently exerted no influence. It had been observed on numberless occasions in the course of routine survey work that early and very heavy mortality overtakes the larvæ of the second generation on cotton. The phenomenon was repeated on this occasion and again in 1939–40. Some loss of buds is caused by the very young larvæ, but for the greater part it is confined apparently to one or two buds per larva ; the larvæ then disappear. At the time of the second generation attack there was considerable shedding of undamaged buds and it would appear that those shed as a result of bollworm damage comprised an inconspicuous proportion, as their loss was not reflected in reduced yields. The observed facts have served to remove some of the anxiety regarding the influence of the second generation and at the same time have aroused much interest and speculation as to the causes. With reference to these causes it may be stated that the rapid and wholesale disappearance of the second generation larvæ cannot be accounted for on the grounds of predator, parasite and cannibalistic action or climatic influences, nor can it be attributed to a shortage of bud, flower and young boll material (which constitute the bollworm's food) on the plants. Recently, however, Rainey, working at Barberton, has found (Repts. from Expt. Stns., E.C.G.C., 1938–39) clear indication that the differences in the mortality rates as between other food-plants of the bollworm are associated with differences in their nutritive value. His determinations of solids-not-fat in the pupæ suggest that protein deficiency may be the main factor in crops where high mortality prevails. Information that the same factor may operate as regards the second generation on cotton is contained in the results of some of F. Crowther's investigations in the Sudan. He found (*Annals of Botany*, Vol. XLVIII, No. CXCII, 1934) that the nitrogen percentage of the dry weight of flower buds fell steadily from 4% at the time

flowering commenced to less than 1·2% in the succeeding 8 weeks. Supposing the same to hold true here, the larvæ of our second generation would consume flower buds with the lowest protein content, a content possibly insufficient for their needs. At present we have no opportunity to explore the suggestion.

It was decided for the 1939–40 experiments to incorporate an early (929), medium (052) and medium-late (5143) strain, which would be exposed to early, late, and both early and late infestations of bollworm, there being in each case very light (control), light, and heavy bollworm treatments as created by hand control and the application of insectary-bred larvæ, according to the amount of natural infestation. As the incorporation of 3 strains, 3 types of application and 3 weights of infestation into an ordinary experimental layout in sufficient replications would involve great difficulties in respect to acreage, variations, material, recorders, etc., recourse was had to the system of confounding devised by Fisher and Yates. The experiment was identical in design with that carried out at Woburn in 1935 on sugar beet.

Interaction of the 3 strains and bollworm treatments in relation to time of boll set and final yields are given in Table III.

TABLE III.
ANALYSIS OF BOLLING TIMES AND RELATIVE YIELDS (LINT IN GRAMMES).
(In terms of means per row of 30 plants.)

Treatment.	*Month.*	*Strain* 929.			*Strain* 052.			*Strain* 5143.		
		No. Bolls Set.	*No. Bolls giving Yield.*	*Yield Lint.*	*No. Bolls Set.*	*No. Bolls giving Yield.*	*Yield Lint.*	*No. Bolls Set.*	*No. Bolls giving Yield.*	*Yield Lint.*
CONTROL (very light natural infestation)	Jan.	431	316	330	369	260	293	347	250	314
	Feb.	1,280	141	131	1,290	223	224	1,449	269	268
	Mar.	128	2	1	213	14	12	173	6	5
TOTAL ...		1,839	459	462	1,872	497	529	1,969	525	587
Light Infestation	Jan.	371	220	245	367	214	265	266	68	96
	Feb.	1,063	198	185	1,240	405	467	1,281	363	422
	Mar.	191	—	—	644	30	24	479	25	20
TOTAL ...		1,625	418	430	2,251	649	756	2,026	456	538
Heavy Infestation	Jan.	323	96	108	214	157	180	231	173	216
	Feb.	1,315	327	357	807	226	245	1,267	435	566
	Mar.	510	37	30	588	24	20	530	105	95
TOTAL ...		2,148	460	495	1,609	407	445	2,028	713	877

Infestation in Table III refers only to the first generation, as again it was found that the second generation suffered wholesale mortality before creating measurable damage. Flowering commenced in the last week of December and the main attack of the first generation was brought to bear over the month of January.

Soil moisture conditions were favourable until February, but there was no rain of value during the whole of February and the first half of March, a time over which the plants normally would be filling out the major setting of bolls ; growth and fruiting thus were restricted and premature ripening-off took place.

The strain 929 tends to put on a quick crop and to close down early, and the dry mid-season conditions accentuated the tendency as regards the plants exposed to the very light, natural infestation, an infestation so light as to be negligible. The plants in question produced over 71% of their crop of lint from January-set bolls. Contrasted with this, and as a measure of direct and indirect bollworm damage, the yield from the January-set bolls of the heavily-infested plants was only 22% of the whole. It is evident, however, from the months of origin in the Table that whereas February settings contributed the remaining 29% of the control crop, 72% of the bolls giving yield from the heavily-infested plants were set in February, with an appreciable number to follow in March. In this case the effect of the early heavy loss of fruit was to relieve the plant during the period of water stress of its burden of well-developed bolls and to keep it in (very noticeably) green growth longer, while it was laying down a re-flush of buds. Later rains allowed maturation of a sufficient proportion of the February-set bolls to give final yields equal to those of the control, albeit a crop late enough to be exposed considerably more to stainers and boll diseases. Had moisture conditions been better, 929 would have carried on longer and yielded more, but so, too, it is probable, would the plants that had been infested, and in the end their standing might also have been about equal to the controls. Formerly the view was held that plants losing heavily from bollworm in the early part of a season that proves to be so unfavourable for the plant as the season under review would have little chance of recovery. The cropping histories of different strains (infested and uninfested) grown under the peculiarly difficult seasons of recent years have modified that view. A case in point is the response of 929 last season. The tendency of 929 to close down earlier than most of the other U.4 strains in being was also exhibited by the plants rejuvenated after bollworm attack. Although later than usual for the strain, the crop was not really late in time of season and was less exposed to stainers than strains of medium and late habits would be when thrown later as a result of bollworm attack.

The effect of the light infestation on 929 was insufficient to exercise much influence on the course of growth and fruiting and, as seen from the Table, there was little difference between this treatment and the control.

There was no significant difference between the final yields of lint in the 3 cases.

It will be observed from the Table that the lightly infested plots of 052 gave considerably the highest yield from this strain, the main source being February-set bolls. Differences in responses in this case are believed to have been due more to irregularities of growth within and between the plots of the lightly infested category than to bollworm damage. Strain 052 was more affected than the other two strains during the dry period and possibly, too, in the chance distribution of plots, it met with more soil differences as patches of plants in certain of the plots exhibited distress sooner than in others of 052 ; leaf fall was early and pronounced. The conditions made it impossible to assess the influence of bollworm damage in all treatments.

The light and heavy infestations of strain 5143 led to later re-flushes of buds which in the former case ultimately produced bolls giving a yield almost equivalent to the control, and in the latter to a yield markedly in excess. Strain 5143 was carrying less and younger fruit when moist conditions were most stringent, and was less visibly affected than the other two strains. The differences in fruiting behaviour were attributable to bollworm damage, and this affords an instance where, in an unusually difficult season for growth, the heavier attack gave rise to a large increase in yield.

Stainers were not numerous over the Cotton Station in general, but later in the season they concentrated in considerable numbers on the late portions of the crop, including the plots of 5143. Actually the late fruit was exposed to a stainer population of the same order as applies to the crop in general in a year of stainer abundance, but, fortunately, the incidence of *Nematospora* was very low and the lint taken from the late pickings was comparatively clean.

The results from these preliminary studies of the interactions of bollworm and strains of different habit suggest that much of value is to be learned from investigations along the lines indicated. Especial regard must be given to the variable influence of the seasons experienced where cotton is grown under rainfall conditions in the presence of American bollworm.

Notes on Nitrogen in Relation to Shedding of Undamaged Buds and Bolls.—It has been noted that heavy shedding occurs when re-flushes of buds are being laid down following losses from the early bollworm attack. Dry mid-season periods in two of the seasons and a very wet period in one of the seasons of observation were no doubt conducive to extra-heavy shedding, but it was considered on the following grounds that the addition of nitrogen might result in some reduction of shedding.

Crowther considers (*l.c.*) that augmented bud-shedding results from competition among developing flower buds and bolls for available nitrogen as well as carbohydrates. The uptake of nitrogen from the soil is proportional to supply, and Mason and Phillis found (*Memoirs of Cotton Research Station, Trinidad, No. 6, Studies on the Transport of Nitrogenous Substances in the Cotton Plant, Part IV*) that carbohydrates increased by as much as 25% when nitrogen was increased from 40 to 80 p.p.m. It is known that the soil utilized at Barberton is now slightly deficient in available nitrogen. The presence here, therefore, of added nitrogen might serve to relieve competition when supplies of nutrients are drawn on most heavily.

Crowther, in the work quoted, considers that nitrogen applications will be most successful when they raise the soil nitrogen concentration during the early growth phase. In the present instance applications at the rate of 200 lb. of sodium nitrate per acre were made one week before flowering commenced. No difference resulted between treatments in the numbers of bolls formed, but the plants having access to more nitrogen carried through a greater number of bolls to maturation. Yields in the case of all three strains were enhanced by about 30%. It should be emphasized that the findings apply to a season in which the early stripping effect of the bollworm induced prolonged vegetative growth and lessened the drain on nitrogen in the plant and, hence, may have retarded the time at which uptake from the soil ceased. Work on these lines should be continued over a variety of seasons, not only in respect to shedding behaviour but also as regards the protein status of food available to the second generation larvæ. When the main fruiting period of the plant is retarded, as the result of an early stripping of buds and young bolls through bollworm action, should there not be ample store of nitrogen in the leaves for transference to a high proportion of the buds encountered by the second generation larvæ ?

Publications.

The following paper was prepared during the season and has appeared in the *Bull. Ent. Res.*, Vol. 31, Part 2, June, 1940. "*Investigations on the American Bollworm*, Part III—Relationships Between Oviposition and the Flowering Curves of Food-Plants."

Investigations on the Red Bollworm.

It was stated in the previous Report that in view of divergence in times of moth emergence from long-resting pupæ at Domira Bay, Nyasaland (first records) and at Barberton, a quantity of the Nyasaland pupæ had been inserted at Barberton for observations on emergence under the conditions here. Barberton pupæ were sent to Domira Bay for the same purpose. Last season the courses of emergence here from

the Nyasaland and Barberton-bred pupæ agreed closely. Unfortunately there was an unduly high mortality among the (300) pupæ sent to Mr. Mitchell in Nyasaland. Up to March 20th only 41 moths had emerged, 32 of them by the end of December and 40 by the end of January, with one to follow in February. Mr. Mitchell reported that upon the examination of the remainder in February a few only were found to be alive. The proportion of the moths out by December 31st agrees with our experience, but the numbers involved were too few for purposes of comparison.

These tests are being repeated. Emergence from the Nyasaland pupæ at Barberton this year—a fresh lot was procured—has been somewhat earlier and proportionately higher than from the locally-bred (Barberton) pupæ. Up to the time of writing (November 20th) 50% of the Nyasaland and 44% of the Barberton pupæ inserted have given issue of moths. On the basis of experience of pupal mortality (in protected cages), these figures probably represent about 80% and 74% respectively of the likely total emergence, and it is fairly evident that again the courses of emergence are in practical agreement.

Moths from the Nyasaland pupæ were paired and larvæ of this first generation have pupated. It is hoped to carry successive generations through the season to observe if any departures from our customary diapause phenomena arise.

Swaziland.—A final year's observations on the red bollworm in relation to natural breeding was carried out by Mr. H. Hutchinson. Mr. Hutchinson has prepared an account of the results and it is hoped that opportunity will be found for assembling the principal data in the form of a paper, *i.e.*, Part II of the red bollworm series.

SUMMARY.

American Bollworm.—Field work in progress since 1936–37, on the course of crop production in cotton in relation to losses from bollworm attack, was continued in greater detail. Principal results from the past three seasons are reviewed.

1937–38.—Plants severely stripped by bollworm at an early stage produced a heavy re-flush of buds; rather more bolls were formed, though fewer matured, than on unattacked plants; the boll weight was lower and the yield considerably less. The importance of the monopodia, as sources of ripened bolls following bollworm attack, was of particular interest.

1938–39.—The separate effects of two generations of bollworm were studied by placing large populations of insectary-bred larvæ on the plants at appropriate times.

The first infestation reduced the yield in the first picking by 50%, but this was partly made up in the second picking by extra bolls from the re-flush, largely on the monopodia. Final yield differences were not significant, though the Controls gave 28% more.

The second infestation did not affect the yield. Early and heavy mortality overtakes the larvæ of the second generation and this cannot be ascribed to factors such as natural enemies, cannibalism, climatic influences and food shortage. It is now considered that protein deficiency may be an important factor here, as appears to be the case with certain other food-plants from Rainey's recent work at Barberton. This suggestion is supported by Crowther's results in the Sudan (*Ann. Bot.*, Vol. XLVIII, No. CXCII, 1934), where he found that the nitrogen content of dry flower buds fell steadily from 4% to 1·2% in the first 8 weeks of flowering.

1939–40.—Early, medium and medium-late strains, 929, 052 and 5143 respectively, were subjected to three weights of infestation—Natural Controls (almost nil), Light and Heavy.

Drought restricted growth and fruiting in February and early March and 929 Controls closed down early, giving 71% of their crop from January-set bolls. Heavily-infested plants gave only 22% of their crop from January settings, but the heavy re-flush brought the total yield up to that of the controls. Plants stripped by bollworm survived the drought and the advantage thus gained balanced the loss of early crop.

The 052 plots were too irregular to give reliable results.

For 5143 the light attack slightly reduced total yield, but the heavy attack increased it considerably. Here the stripped plants survived the drought more completely and thus derived actual benefit from the stripping.

A top dressing of 200 lb. per acre of nitrate of soda, applied one week before flowering, did not affect the number of bolls formed, but increased the number matured and raised the yield by 30%.

Publications.—The following paper was published—" Investigations on the American Bollworm, Part III — Relationship between Oviposition and the Flowering Curves of Food-Plants "; *Bull. Ent. Res.*, Vol. 31, Part 2, June, 1940.

Red Bollworm.—In view of divergence in times of moth emergence from long-resting pupæ of the bollworm in Nyasaland and at Barberton, observations have been carried out during the past two years on Nyasaland pupæ here and Barberton pupæ at Domira Bay. There appears to be no essential difference in the courses of emergence under our conditions. Results at Domira Bay were obscured by high

mortality of the pupæ last year. The results for the present year are described in the Report from Nyasaland.

Attempts are being made at Barberton to carry successive generations of the Nyasaland material through the season to observe if any departures from our customary diapause phenomena arise.

Swaziland.—A final year's observations on the red bollworm in relation to natural breeding were carried out by Mr. H. Hutchinson. An account of the results has been prepared and it is hoped that opportunity will be found for assembling the principal data in the form of a paper for publication.

SWAZILAND

COTTON EXPERIMENT STATIONS, BREMERSDORP AND CROYDON.

PROGRESS REPORT FOR THE SEASON 1939-40.

BY

J. V. LOCHRIE.

Introduction.

On the outbreak of war the Corporation's staff was placed at the service of the Swaziland Administration. The Administration were of opinion that the continuity of the Experiment Station work should be maintained as far as possible and as a result this work has continued unchanged. Mr. Hutchinson's work on insect pest survey terminated at the end of the present season, and from that time he has been employed in furthering the development of cotton-growing in the native areas and in assisting the Government food production campaign.

The lines of work on the Stations have closely followed those of the preceding season. Strain tests of cotton were carried out in collaboration with the Barberton Station. The investigations on the effects of cotton seed disinfection were continued, and fertilizer experiments on both cotton and maize. Selection work and strain tests were carried out on the promising flint maize and red kaffir corn material.

There was little increase in commercial cotton, but the demand for seed for next season has shown a considerable rise. A specially encouraging feature is the revival of interest amongst natives following Mr. Hutchinson's preliminary work in the native areas.

Meteorology.

Bremersdorp.—The total rainfall was high — 43″ from September to the end of June — and the distribution bad : the excessive rains during early growth being followed by a protracted dry period during February and early March.

Excellent early planting was followed by wet and cloudy conditions during November and early December. Considerable losses of seedlings occurred at this time in cotton which had not been acid-treated or otherwise disinfected. Rainfall in January was still rather heavy, but the temperatures were higher and the crop developed well. Flowering was checked by the dry period in February and March, but at that

stage the crop prospects were good. A heavy infestation of American bollworm occurred in March, but the loss of bolls was not severe, the bulk of the egg-laying being absorbed by an adjoining field of kaffir corn. Stainer appeared early in large numbers and the final yield was below expectations at around 900 lb. seed-cotton per acre.

Croydon.—As at Bremersdorp the rainfall was high—19″ fell in November and December, while only one effective fall occurred between February 1st and March 9th. The soil is a light sand and, with temperatures ruling higher than at Bremersdorp, the crop did not suffer from the heavy rainfall in the early stages. Flowering ceased during February and the useful crop of nearly 1,000 lb. seed-cotton per acre was reaped from bolls set before mid-February. The crop was almost completely free from insect damage.

Agriculture.

Fertilizer Experiment.—The two-course fertilizer experiment was planted to cotton at Bremersdorp. With the exception of one series receiving compost plus phosphate each year, the fertilizer treatments are applied in alternate years to the maize crop. The series receiving fertilizer each year was significantly higher-yielding than all others. In addition, there was a significant yield increase from residual compost effect, but none from residual phosphate. Owing to possible loss of yield from stainer damage, green boll counts were made and the results followed closely the trend of the yield figures.

Cotton Variety Trials.

The trials at both Stations were exclusively of U.4 strains from Barberton, mainly derivatives of the successful 052 and 921 families. At both sites the crop was planted under good conditions and excellent stands were obtained. On the light sandy soil at Croydon the plants did not suffer from the high rainfall. The long drought in February and March shut down the crop and, with such an extremely short season, the yield exceeding 900 lb. seed-cotton per acre was good. A feature was the almost complete absence of bollworm and stainer. At Bremersdorp the position was different as the wet, sunless conditions slowed up the crop. In the later dry period the crop came on well and promised to be exceptional ; the relatively low yield of 900 lb. per acre is attributable to the early influx of stainer and, to a less degree, to an infestation of American bollworm in March.

At both Stations significant differences in yield were obtained, mostly as between early and late strains, the later strains being generally better at Croydon and the reverse at Bremersdorp. One early 052

strain, however, 7114, was very good on both Stations. The poorer yields from the later strains, derivatives of 921 and 920, at Bremersdorp was partly due to the loss of the late crop through stainer damage.

Seed Disinfection.

The investigations on the effects of cotton seed disinfection, started two seasons ago, were continued, but with modifications in the light of the results previously obtained. The development of the work and the main results have been outlined in the reports of the previous two seasons. In the report of 1938-39 it was noted that the guard hedges between plots afforded only partial protection from interplot infection and this season a more effective guard of hedges of kaffir corn and velvet beans was provided.

Germination.—The treatments, which were sulphuric acid treated seed (S.A.), Abavit treated (Ab), and ordinary ginnery delinted seed, showed no significant differences in the total number of seedlings produced. It was hoped to get further information on the value of disinfection in reducing loss by soil-borne fungi, but unfortunately the losses seen in another section of the Station did not occur in this experiment. (S.A.) did not show the increase in germination rate of the previous experiments and it is considered that the very close delinting of the ordinary seed tended to reduce the superiority of the acid-treated seed. Dry matter determinations gave higher weights from the acid treatment than from Abavit or untreated seed, between which there was no difference.

All treatments were alike in total flowers produced, but (S.A.) and, to a lesser extent, (Ab.) produced a higher proportion of flowers in the important early part of the season and this was reflected in higher yields.

Bacterial Disease.—Regular counts of seedlings affected with Angular Leaf Spot were made and, as in the previous experiments, a high measure of control was obtained by seed disinfection. At the time of thinning the untreated plots showed 30% infection, against 3% in the (Ab.) series and under 1% in the (S.A.) series. Two weeks later there was negligible increase in the (Ab.) and (S.A.) series, while the infection in the untreated plots had risen to 85%. These results corroborate those of the previous year.

Rotation Crops.

The season was a poor one for rotation crops except in the case of early-planted maize. These early crops were favoured by the good rainfall, but other crops such as kaffir corn and groundnuts, which are

planted in November and December, were adversely affected by the lack of sun after planting and were severely hit by the long drought at flowering time.

Maize. Fertilizer Experiment.—Maize was planted on the fertilizer layout at Croydon. The experiment is in its 4th season, having been cropped with cotton and maize in alternate years. In last season's report the very considerable yield increases following applications of compost and, to a lesser degree, phosphate, were noted. Before discarding the simple layout for a more complex experiment, it was decided to replace the " no fertilizer " series by one receiving phosphate plus a top dressing of nitrate of soda. The soil is a light sand in poor heart and the expected low yields were accentuated by the dry February. The yields are given below :—

Treatment.	*Rate of application per acre.*	*Yield, in lb. per acre.*	*Green weight at tasselling, % of P.*
P.	200 lbs. Supers	680	100
K.M.	6,000 lbs. Compost	908	133
K.M.P.	K.M. plus P.	1,068	137·5
P.N.	200 lbs. Nitrate of Soda plus 200 lbs. Supers ...	1,529	169

The feature of the experiment was the large increase in yield and plant size in the P.N. series. The results indicate that the striking increases in yield on this soil following compost or kraal manure are due to a considerable extent to nitrogen contained.

Selection.—In the previous report it was noted that the breeding material had been reduced to 4 main strains, all of white flint type. Sufficient seed of the progeny was available for progeny tests and the season's strain trials have made possible the rejection of one family. The continued success of strain C.1 and its derivatives is encouraging and a start is being made in replacing the present seed stock for general cultivation.

Kaffir Corn.—As described in earlier Reports the original strains selected were of dwarf type and were white seeded. These strains proved well suited agriculturally to the country, but the native preference is for red grain. Crosses were obtained between the dwarf early maturing whites and the late red-seeded native type and from these crosses uniform red-seeded early dwarf strains are now available. Progeny tests have demonstrated the superiority of three main strains :—P.133, 74/T. and the very short-stemmed P.127. These are now available for distribution and are in considerable demand among growers.

Groundnuts.—Experiments were continued on methods of cultivation. Cultivation on the flat was compared with the practice

of ridging up the plants at flowering. The yields were low, due to the long dry spell during the critical flowering period, but the results at both Stations showed no difference in yield or in shelling percentage between the two treatments. This confirms the results of previous experiments and it is concluded that no advantage is to be gained by earthing-up the crop.

A comparison between the planting of kernels and unshelled nuts was described in the Report of last season. In that year the conditions were excellent for breaking up the pods and no difference in flowering, yield, or shelling percentage was obtained. This season the conditions were less favourable for quick break down of the shells and the resulting delay in germination considerably reduced the yield.

Summary.

(1) The season was one of high, but poorly distributed rainfall. Heavy rain and lack of sun affected the cotton crop in the early stages and a protracted dry period later tended to shut down the crop early. At Croydon the season was marked by an almost complete freedom from insect pests, but at Bremersdorp stainer was the main factor in reducing yields.

(2) Fertilizer experiments on both cotton and maize were carried out. At Croydon large yield increases followed applications of compost and still greater increases were obtained from top dressings of nitrate of soda. At Bremersdorp significant increases in yield followed applications of compost and phosphate. The residual effect of compost was marked, but the residual effect of phosphate was negligible.

(3) Tests of cotton strains were carried out, the strains being derivatives of the successful 052 and 921 families.

(4) The investigations on the effect of cotton seed disinfection were continued. Seed treated with sulphuric acid and, to a slightly less extent, seed disinfected by Abavit showed markedly less infection by Angular Leaf Spot.

(5) In experiments on the cultivation of groundnuts it was seen that earthing-up of plants had no advantage over cultivation on the flat.

PROGRAMME FOR THE SEASON 1940-41.

Bremersdorp and Croydon.

The experimental work will in general be a continuation of that of last season.

1. Trials of cotton strains from the Barberton Station will be carried out as in previous years.

2. The investigations on the effect of seed disinfection of cotton from the point of view of control of bacterial disease, influence on germination, growth, and crop development, have continued over three seasons. This section of the work has terminated, but to complete the investigation it is hoped this season to obtain more precise information on the effect of the disinfectants in controlling disease of seedlings.

3. The fertilizer experiments on maize will be continued and expanded.

(*a*) The experiment described in the programme of 1938–39 on the direct and residual value of compost will be continued.

(*b*) The combined fertilizer and rotation experiment—also described in the 1938–39 programme—will continue. This is the 3rd year of the experiment and the first comparison of continuous maize with maize rotated with cotton will appear.

(*c*) The fertilizer experiment at Croydon, which has shown very large increases of yield from small compost applications and from nitrate of soda in the past season will continue for one more season in its present form.

(*d*) Following the results obtained in simple fertilizer trials, more comprehensive experiments will be started on the different soils of the two Stations. These will include levels of nitrogen, phosphate and potash in all combinations.

4. Owing to lack of a suitable site the investigations on green manuring were not carried out last season. It is hoped to include these in the present season.

5. The breeding work on maize and kaffir corn will continue. Seed of improved strains is being used with success.

SOUTHERN RHODESIA

PROGRESS REPORT FOR THE SEASON 1939-40

BY

G. S. CAMERON.

Introductory Note

The outlook at the commencement of the season under review was far from promising. The previous season had been a poor one owing to excessive rains, and it was doubtful if many farmers would have the heart to continue with a crop of which the price has been low for a number of years. Before the outbreak of war the Corporation offered the loan of the services of their technical staff to supplement the Agricultural Departments in countries where the need was greatest, to assist in carrying out urgent war-time measures, such as increasing the production of food crops and other agricultural products. The Government of Southern Rhodesia, when notified of this proposal, were good enough to assure the Corporation that if the need arose they would raise no objection to the transfer elsewhere of the technical staff of the Gatooma Station ; subsequently a request for the loan of as many officers as could be spared reached the Corporation from Tanganyika, and three members of the staff left Gatooma on transfer in October, 1939. There accordingly seemed little possibility of attempting to do more than place the Station on a maintenance basis. The following report is a record of what has been done on the Station ; it omits reference to any work that was attempted, but had to be abandoned through sheer inability to do more than a limited amount.

In the districts, the acreage planted to cotton was greater than anticipated, and as both quality, and yields were good, the growers will be rewarded with better financial returns than there was reason to expect at planting time. This year's demand for planting seed indicates that the acreage to cotton will be doubled in the European areas.

The year's output was 353 bales as compared with 73 in the previous year.

A very considerable increase in the production of native-grown cotton is to be recorded. This, of course, is due to the special propaganda tour undertaken last year. The quality of the cotton was excellent, practically all of it being picked, and sorted. Up to date the

amount of seed cotton purchased has been 105,091 lb. compared with a total of 13,741 lb. last season.

It may be added that, when Natives pick their own cotton, they do so much more carefully than when employed on farms or on the Cotton Station.

The Native Department is keenly interested in the furtherance of the native cotton-growing industry, and the recently-appointed Chief Native Commissioner has already given proof of his willingness to co-operate in the same helpful spirit as his predecessor. The fact is that there are many potential cotton-growing areas where the marketing of surplus maize is uneconomic, and this applies to certain European occupied areas as well as to the Native Reserves. It is not known to what extent the Native Reserves will grow cotton this season, as last year's propaganda tour has not been followed up.

The Cotton Research and Industry Board continued to function smoothly throughout the year, and this opportunity is taken of recording thanks to the several members for their persevering interest.

Again, as in former years, the Government of Southern Rhodesia has been actively helpful. The Minister of Finance and Commerce, The Hon. J. H. Smit, M.P., is responsible for the administration of the Cotton Research and Industry Act, under which the Board operates. War time conditions take an ever-increasing toll of his time and activities, but he always manages to keep in close touch with what is being done in connection with the cotton growing industry, and his far-sighted attitude towards it is gratefully acknowledged.

COTTON STATION, GATOOMA.
PROGRESS REPORT FOR THE SEASON 1939-40.

Meteorology.

Taking the country as a whole, climatic conditions were favourable to the cotton crops, but this does not apply to the Cotton Station where effective rains were late in arriving. Elsewhere, early rains enabled

farmers to prepare their lands and obtain a fine tilth ; planting was carried out under favourable conditions, and the cotton crops throughout the country made a good start. Subsequent rains were evenly distributed, and the growing season was marked by the absence of long droughts which so often have been noted in February and March. The total rainfall for the season amounted to 33·20 inches, compared with 46·23 inches the previous year.

On the Cotton Station, the rains were late and planting was not possible until the 12th of December. This meant that the cotton flowered about the same time as the American bollworm moths were actively egg-laying, and a heavy cotton crop was not anticipated on the Station.

Agriculture.

The practice of leaving the land in large clods after ploughing, instead of breaking it down immediately by rolling with a Cambridge roller, or disc harrowing, or both, is one which requires consideration. The season under review was a case in point, and one which deserves mention. If, after autumn ploughing, the soil is not partially broken down, it is apt to dry out and become exceedingly hard. In the following spring, hard dry lumps of earth have to become saturated with moisture from the early rains before they crumble of their own accord, or are broken down mechanically. This is necessary in order to prepare a moderately fine seed bed. Last year the lands were left in the rough state after ploughing, and the early and light spring rains had no effect upon the large clods. By the time the heavier rains set in, the seed should have been in the ground and ready to germinate, but the land was much too rough for the planters. Clods, which were so saturated on the upper surface and sides that the disc harrows became clogged when put on to break them down, were still dry and hard in the centre and on the under surface. Altogether this meant a delay of ten to twelve days in planting in a year of late planting rains ; a delay which makes all the difference between good and mediocre yields, and furthermore, a delay which can be avoided, and need not occur. These facts have been recorded because there are a number who hold the view that it is better to leave the land alone after ploughing, and not attempt to obtain a tilth until the arrival of the spring rains.

An observation worth recording is that the late-planted strain 7 L.1 on the Cotton Station gave a much lower ginning percentage than the same strain planted earlier elsewhere. The figures are 31·63% and 34·5% respectively. This is corroborated by observations on the Cotton Station itself. Single-plant selections of 7 L.1 from

earlier, hand-planted observation blocks averaged 35·38% against an average of 31% from single-plant selections made in the later planted commercial crop. It would be interesting to know whether any correlation between date of planting, and ginning percentage, has been established elsewhere.

The cotton germinated well, and made steady progress under ideal growing conditions. The late start, however, brought the main flowering periods into the most active period of American bollworm attack. Thus a heavy toll of flowers was taken, and the plants continued to grow to an extent that became excessive, especially on the richer land.

The average yield per acre of the field cotton was 456 lb. compared with the previous year's average of 380 lb. The previous year, however, was one of exceptionally heavy rains, which accounts for the lower yields.

Out of nineteen observation blocks, made up of a variety of strains, more than half yielded at the rate of 1,000 lb. per acre and over, but these were hand-planted, ten days earlier than the cotton fields.

Maize yields were on a high level, the average for the Station being 16·3 bags per acre against 11·3 bags in 1938–39. (A bag of maize weighs 200 lb. nett.)

Compost Trials.

Cotton.—Four composted cotton trials were laid out, but only one gave significant results. This consisted of applications of compost at the rates of 0, 2½ and 5 tons per acre. The result is tabulated below :—

C.D. Compost Trial.—Plant "A"—1st Year Effect on Cotton Strain 7 L.1. Three Treatments, each Replicated 8 Times.

Rate of application of compost per acre.	0 *tons.*	2½ *tons.*	5 *tons.*
Yield of seed cotton, in lb. per acre	258	275	314

Difference required for significance (P = ·05), 33 lb.

Maize.—Two compost trials on maize were carried out, but only one gave a significant result.

H.C. Composted Maize Trial. 2nd Year Effect. Four Treatments. Latin Square. Replicated Four Times.

Rate of application of compost per acre.	0 *tons.*	2½ *tons.*	5 *tons.*	10 *tons.*
Yield of maize, in bags per acre (Bag = 200 lb.) ...	18	20·2	20·3	21·7

Difference required for significance (P = ·05), 3·21 bags.

Early in the year it became obvious that many of the trials would not turn out satisfactorily. Flowering records indicated this in the case of cotton, but the maize and cotton plots both looked irregular and patchy during the growing period. It is not known why this should be so, but it may have been due to the excessive rains of the previous season causing an uneven surface wash of soil on these, and adjacent plots.

For this reason the lands in question are being put out of commission for conducting trials in the ensuing year.

Livestock.

The fattening of steers for export as chilled beef to the Smithfield Market was continued in order to ensure an adequate supply of dung and urine for the manufacture of compost. Out of the first 21 head tendered to the Rhodesian Cold Storage Commission, 16 were graded "Imperial", the highest grade, and 5 as Standard "A", the second grade.

A further batch of 24 steers have been prepared, and are now ready for the cold storage works, but the results will not be known in time for inclusion in this report. It is anticipated, however, that they will finish as well as, if not better, than the first batch.

Implements and Machinery.

The making of compost entails much wagon work in collecting maize stover, sunn hemp, grass and waste material, all of which is light but bulky. The 5-ton wagons in general use are not suitable either for collecting waste material, or for distributing the compost when made. Before the outbreak of war a set of pneumatic tyres and axles was ordered, and a low wagon was built on the Station by the Native carpenter. So far the results have been satisfactory, but it remains to be seen how the pneumatic tyres will stand up to the rough ground which has to be traversed in collecting maize stover and waste material.

Early in 1939 a manure distributor was purchased to find out whether it would be suitable for distributing compost. Distributing compost is a very different proposition from distributing farmyard manure, and this machine as received, was not a success. By dismantling several unnecessary chains and cog wheels, and the addition of a simple, farm-made, wooden contrivance, it is hoped that the machine may prove effective next season.

Genetics and Breeding.

The strain 7 L.1 has been bulked up on the Cotton Station, and on certain selected farms dispersed throughout the country. Except

where late-planted, it has given very satisfactory yields coupled with higher ginning percentage, and there is a slight improvement in quality.

Sufficient seed of this strain is now available to make a general issue which will replace the former strain G.5.123, now withdrawn from commercial use.

A small bulk of 7 L.5, a closely related strain to 7 L.1, was grown in order to increase the seed supply in case it might prove eventually to be a better strain than 7 L.1. In length and strength of staple it is one of the best strains on the Cotton Station, but for some reason, possibly its late opening in a year of late planting, its performance in the field compared unfavourably with that of 7 L.1.

Single Plant Selection.—A number of observation plots were planted consisting of types ranging from U.4 Mixed Bulk to some of the 1939 strains. As these were hand-planted ten days earlier than the machine-planted field cotton, most of the single-plant selections were taken from them.

One hundred and twenty-five selections were made, and of these fifty were rejected after laboratory examination and analysis. The seventy-five that have been retained will be carried forward to progeny rows for further study. The largest number of selections were made from 7 L.1, followed by one of the Station crosses, 6 C.6, which contains very promising material. Perhaps the most interesting strain of the lot, one of the 9 L Series, is that numbered 9 L.36. It is a small, very prolific plant, much earlier than any other cotton on the Station; open, sympodial type, with small leaves, and very good opening. Unfortunately its lint is far short of what has been aimed at in previous years, but some of the re-selections indicate that improvement may be expected in this direction. Particular interest is attached to this strain in view of the possibility of a local market being established which would not require cotton of the same quality as grown in the past.

Colchicine Treatment.—Prior to the war a small amount of Colchicine (1 gramme) was procured in order to note what effect it might have on cotton, and whether it would be useful in producing mutations. On the outbreak of hostilities, and the transfer of the technical staff to Tanganyika, the idea was shelved. Later in the season, however, during a lull in the Station activities enforced by weather conditions, the idea was revived. With neither knowledge nor experience of the drug, and very little available literature on the subject, such work as has been done must be considered exploratory. This, coupled with the absence of technical staff, meant that what has been done is lacking in precision. Nevertheless some of the results may be worth recording.

The strength of the Colchicine solution used was 0·186%. Seeds of the following cottons were soaked for 16 hours in this solution, and the survivors planted out immediately. All seed used had been delinted with sulphuric acid except seed of the local native cotton (*G. herbaceum var. Africanum*, Hutchinson and Ghose). Owing to the thickness of its seed coat, kernels of the latter were extracted and treated direct. About 50 seeds of the varieties and strains were soaked and planted, and the germinations recorded as below :—

Native cotton	No survivors
Bancroft	No survivors
Cambodia	1 very weak seedling
9 L.10	8
9 L.36	22
9 L.26	15
7 L.5	22
9 L.34	7
9 L.18	25

Except in the case of the native cotton, the controls planted alongside, produced vigorous healthy seedlings.

It soon became apparent that there was considerable variation in the reaction of the seedlings to the seed treatment, not only between strains, but within the strains themselves, and it was decided to take flowering records. Each plant was selfed, and later picked separately.

Flowering graphs were made of each treated strain along with its control, and these are very interesting, but the variations within the strains were so great that the graphs are of little value except for inter-strain comparisons. Even so, some of the results are worth mention.

9 L.10.—In the treated plants, flowering was much more vigorous from the start, and they maintained their lead in production in comparison with the controls.

9 L.36.—Flowering was retarded from the beginning and remained so until near the end of the season, when there was a barely perceptible increase.

9 L.18., *9 L.26.*, *9 L.34.* Flowering was retarded at commencement but caught up on controls about a month to six weeks afterwards and then took the lead.

7 L.5.—The reaction of this strain to the treatment was more marked than any of the others. Variation was much greater, ranging from small miserable looking plants to tall, vigorous flowering bushes. About a week after flowering commenced the treated plants began to produce more flowers than the control. In about another two weeks the flowering shot ahead, and continued to increase long after flowering of

the control plants was on the decline. By the fourth week in March, the control had declined to 0·2 flowers p.p.d. At this time flowering of the treated plants had reached the peak of 2·3 flowers p.p.d.

In this line occurred the only two " freaks " resulting from the Colchicine treatment. They were side by side in the row, and each behaved differently from the other except that neither produced seed. " No. 16 " was a thick stocky plant, with large leathery leaves, late in flowering and not prolific; enlarged flowers, anthers, and pollen grains. " No. 17 " was exactly the opposite. A slender delicate plant with smaller leaves and flowers, very prolific. Anthers and pollen grains were much reduced in size. Actually this plant produced one seed with normal lint, but the seed itself was damaged. Both plants are being propagated vegetatively for more detailed examination if time and opportunity permits. It is suggested that " No. 16 " is a polyploid, and that " No. 17 " may have undergone a process of reversion.

Taking the Colchicine-treated plants as a whole it is obvious that they have responded to treatment in varying degrees. Some have reacted badly while others appear to have improved. Records have been kept of mean heights, weights of seed cotton per plant, ginning percentages, and mean weights per 100 seeds, as well as the flowering records, and lint characteristics. Progenies of all plants, good and bad, will be grown in the ensuing season, and similar records taken for purposes of comparison. One character, " hairiness " has not been mentioned because the evidence is too conflicting. Attempts to estimate this character were made, but the process is too long and involved as yet to be practical without an increase in staff.

Entomology.

Insect Pest Control investigations have had to be suspended, but in order to assess the incidence of insect attacks a certain amount of recording was undertaken, except for jassids. Jassid attack was not bad until the end of the season when it appeared to be heavy in the rank overgrown cotton on the richer soils. Even so, it did not seem to do much damage.

Stainers.—Contrary to the findings of the two previous seasons *D. fasciatus* was not present to the same extent as *D. intermedius*, or *D. superstitiosus*. *D. intermedius* was present in greater numbers than *D. superstitiosus*, but both continued to the end of the season. *D. fasciatus* seemed to disappear in April, but re-appeared towards the end of the month, and early in May. As usual, the heaviest infestations were on the overgrown cotton on the better soils. Stainer damage to the cotton was not serious.

American Bollworm.—American bollworm attack appeared to be heavy, but the records are not very satisfactory in this respect as there was a delay in getting the necessary counts and observations started.

Sudan Bollworm.—The attack was light, but the pest appeared in small numbers about the middle of April to the end of the month. Egg-laying reached its peak in the second week of April, but dwindled rapidly and was no longer evident by the first week in May.

Aphis.—Aphis was almost negligible, and there was very little evidence of it throughout the season.

Locusts.—Locusts were a constant source of worry for the greater part of the season. Sporadic visits of flying locusts were driven off from time to time, but continual watch had to be kept on attacks in the hopper stage. From February until the end of April, and even into May, they caused considerable worry and trouble. Native watchmen had to be employed permanently on the look-out for them, and gangs of boys had to be taken, at short notice, from other work. At times they caused serious dislocation of routine operations.

An idea has got afoot that locusts only attack the outer rows of cotton fields, and if left alone will advance through the crop without doing further damage. There may be something in the idea, but it would take a considerable amount of courage to put it to the test.

Mycology.

Although the season's rainfall was not so heavy as that of 1938–39, it was nevertheless what would usually be considered a fairly wet season. Following as it did one of the wettest seasons on record, humidity was high, and the soil quickly became saturated, and remained in that condition for a great part of the growing period. In those circumstances it is not surprising that Angular Leaf Spot became more prevalent than usual. In Southern Rhodesia, Angular Leaf Spot is not considered a serious disease of cotton as it rarely develops beyond the primary stage. This year, however, it went further and developed into Blackarm. Specimens of branches and stems with characteristic lesions were sent to the Plant Pathologist in Salisbury, who corroborated the diagnosis. A twenty-acre field near Bulawayo was very badly infected with Angular Spot but there was no evidence to show that it developed into Blackarm, and a crop of over 1,000 lb. seed cotton per acre was finally picked from the same field.

Over one part of the Cotton Station there appeared fairly large patches of what looked suspiciously like some form of wilt. Dr. J. F. C. Hopkins, Government Plant Pathologist, was called in to investigate,

as wilt disease of cotton has not been recorded previously in Southern Rhodesia. He finally came to the conclusion that the wilt must have been caused entirely by the Blackarm organism.

Summary and Conclusions.

The season has been a favourable one for cotton throughout Southern Rhodesia but effective rains were late on the Cotton Station at Gatooma.

The practice of leaving land in the rough after autumn ploughing is criticised, and last season's experience cited in support.

Observation is made on late planting and its possible effect on ginning percentage.

Attention is drawn to the heavier yields obtained from plots planted ten days earlier than the main cotton fields.

Good maize yields were obtained and the average yield quoted.

Results of compost trials on cotton and maize are given, and a reason suggested as to why other trials were a failure.

Details are given of the first batch of cattle fattened for the chilled beef industry.

Comment is made on a farm-built wagon for collecting farm waste, and on a manure spreader converted for use as a compost distributor.

The behaviour of the strain 7 L.1 is recorded. It is to replace the strain previously in general cultivation.

Single-plant selections have been made, and two parent strains specially mentioned.

Results of exploratory work on Colchicine treatment of cotton seed are mentioned, but conclusions avoided until progenies of treated plants are studied in the ensuing season.

Jassids, stainers, and Sudan bollworm did not do much damage. There was little evidence of aphis throughout the season, but American bollworm attacks appeared to be heavy. Locust attacks were beaten off, but they were a continual source of trouble and upset the Station routine over a prolonged period.

Angular Leaf Spot was widespread throughout the country but does not appear to have done much damage ; Blackarm was in evidence on the Station at Gatooma. At one time wilt was suspected but was not corroborated after diagnosis.

PROGRAMME FOR 1940-41.

It is intended to plant about 300 acres, more or less, of which maize will take up about 150 acres, and cotton about 82 acres. The remaining crops to be planted are sunnhemp, 37 acres ; groundnuts, 8 acres ; Dolichos beans, 6 acres, and about 10 acres of Rhodes grass which will be ploughed in after the final cut has been taken off it.

Two sets of trials are planned, with the possibility of a third set. These have been moved to where the soil is poorer, and where trials have not been carried out for a number of years. They are designed to give information on the rotational value of cotton to the succeeding maize crop, without compost or artificial fertiliser, but the effect cannot be ascertained until 1942. The other plan is to try and find out if there is any difference in the method of applying compost. Certain plots have had the compost harrowed in, while others have had the compost ploughed in. These plots will also be available for cotton rotation trials in 1942.

There is another reason for moving the trials on to less fertile soil. Farmers usually plant their cotton on worn-out maize land, and that rarely yields more than five or six bags of maize per acre. It seems unwise, therefore, to continue trials on land of high fertility which farmers would rarely plant to cotton.

The 1939 single-plant selections which were not planted last year will be carried on to progeny rows as well as the 1940 selections. This will entail a considerable amount of selfing.

Two small bulks of about one acre each are being made from strains that were grown in last year's observation blocks.

Seed of the colchicine-treated plants will be planted in progeny rows, and compared with the behaviour of the parent plants and with controls of the same strains.

The fattening of cattle, and the manufacture of compost, will be carried on as formerly.

[*Included by courtesy of the Uganda Government.*]

UGANDA

COTTON EXPERIMENT STATIONS, KAWANDA AND SERERE, PROGRESS REPORTS FOR THE SEASON 1939-40

Introductory Note.

BY

THE DIRECTOR OF AGRICULTURE.

Cotton in Uganda, being a rain-grown crop, is at the mercy of the weather, over which no control is possible. Certain of the effects of weather on cotton can, however, be controlled to some extent by the application of science. For instance, excessive rain at certain times of the year may cause a rapid spread of Blackarm disease and thereby reduce yields considerably. The breeding of varieties resistant to Blackarm reduces this chance to a minimum. Again, excessively dry conditions may bring on a serious attack of jassids which may likewise be controlled by resistant varieties. The incidence of *Verticillium* wilt appears to be connected with soil temperature, in itself practically outside control; varieties resistant to wilt minimise this danger. Some indirect control over the effects of climate is thus possible and this may be carried even further by breeding for drought resistance, early maturity, storm-proof bolls, etc. In Uganda our plant breeding, plant pathological and entomological experts have gone a good way along the road to obtaining resistance to Blackarm and jassid, and there is indication of wilt resistance in some strains grown at Kawanda, while at Serere resistance to *Lygus* attack appears to be a distinct possibility. As so often occurs in plant breeding, resistant strains are very seldom the most desirable strains as far as other characters such as quality are concerned, and in Uganda we have embarked on a programme of hybridisation between strains having good lint characters and strains resistant to disease which promises to produce some valuable material.

We are by no means neglecting the cultural side of the picture. The present spacing adopted by cultivators in Uganda is too wide; an intensive campaign to improve matters in this respect has met with considerable success and it is reasonable to expect big increases in yield per acre when the full effect of this improvement is in force. All experiments on sowing dates point to the benefits of early planting.

Propaganda to encourage early planting is having effect, but in Buganda in particular the whole question of planting dates is closely connected with the harvest of food crops, which is dependent on the time the food crops themselves are planted. It is very satisfactory to be able to report that cultivators in many parts of the Protectorate are becoming much more responsive to advice than they were a few years ago and they are beginning to realise that the Agricultural Officer is a friend on whom they can rely for sound practical advice.

Soil conservation work is largely bound up with the cotton crop, and cotton planting up and down the slope is now the exception rather than the rule. In most parts of the Protectorate it appears that strip cropping will be the solution to the soil erosion problem and our first objective is to get the cultivators to become strip minded. Across-the-slope planting is the thin end of the wedge and a step further has been reached this season in Teso where large numbers of cultivators have left strips of grass at intervals across their cotton plots. Cultivators in Uganda are conservative as are farmers throughout the world and they are slow to take up improved methods of cultivation ; once they try them and satisfy themselves that the new methods are worth while they are willing to incorporate them in their system of farming. Even with soil conservation measures, once the effect of bunds and strips in holding up soil becomes obvious to the eye, cultivators realise their value.

KAWANDA ZONE.

BY

G. W. NYE.

Introduction.

The season was the second abnormally dry one in succession. Despite the dry conditions, very satisfactory yields were obtained from the early sowings at Kawanda. Diseases and pests were again less prevalent than usual.

Meteorology.

Rainfall was very spasmodic during the planting period and it was extremely difficult to plant under good conditions. Unusually dry weather towards the end of 1939 resulted in a sharp picking peak and no second crop was formed ; in consequence very poor yields were obtained from the late sowings, and all the late maturing varieties suffered in yield. Heavy rains in February 1940 caused damage to the crop in the field and spoilt the grade during that month.

Agriculture.

A sowing date trial was planted at Kawanda to ascertain whether early plantings give the highest yields as at Bukalasa. The original intention was to commence planting in the middle of May and to continue at fortnightly intervals until the middle of August. Unfortunately it was impossible to get the land ready for planting before June, and owing to the irregular rainfall it was not possible to plant at regular fortnightly intervals. September sowings were employed to make up for the lack of early plantings ; the results from these very late sowings are of interest as they demonstrate very forcibly the futility of late planting. The yields obtained are shown below :—

Planting Date.	*Lb. seed cotton per acre.*
June 3rd	1,145
June 29th	865
July 10th	780
July 29th	665
August 14th	595
September 5th	284
September 16th	178
Least significant difference	226

Cotton Seed and Green Manure Trial, Bukalasa.—This was continued and the manurial treatments were applied. The yields were the highest that have been obtained since the experiment started in 1933, and it is remarkable that the control plots (no cotton seed or green manure) are still giving almost as good yields as the plots treated with 4 tons of cotton seed, with and without green manure, every other year.

Soya Beans.—Two variety trials were planted at Kawanda, one during the early rains and the second during the late rains. The former gave much the best yields. Four strains from South Africa did very well, as did the Venezuelan strain obtained from the Imperial College of Tropical Agriculture, Trinidad, some years ago. In the first trial the best yield was 950 lb. of shelled beans per acre, and in the second 680 lb.

Cotton Genetics and Breeding.

The Breeding Plot consisted for the most part of derivatives from B.181, B.P.50 and S.P.102. The B.181 derivatives were grown in an endeavour to obtain better quality lint from this strain, which is so valuable for its resistance to Blackarm and wilt. The year's results showed little or no success, and only one Pedigree Line, B.P.213, produced rather longer lint than the general run of this strain. The B.P.50 derivatives were all heavily infected with Blackarm. Unfortunately the incidence of wilt was sporadic and less than normal, so the season was unsuited for selection against this disease. The S.P.102 derivatives varied considerably; their staple was short, but all appeared resistant to Blackarm.

The hybrids consisted chiefly of crosses and back-crosses between B.181 and B.P.52. Of these a selection made in the F_1 generation back-cross B.181 × (B.181 × B.P.52) was the most successful; (the female parent is quoted first) in fact, judged on a combination of the four characters—lint length, ginning percentage, resistance to Blackarm and resistance to wilt—it is superior to any of the Pedigree Lines. Further selection in this back-cross should produce some valuable material. In the simple crosses between B.181 and B.P.52, Blackarm resistance appears to be transmitted by the female parent. In other words B.181 used as the female gives better resistance than the reciprocal cross. It is noteworthy however that by selection in the F_2 generation of this reciprocal cross it is possible to improve Blackarm resistance up to the level of the better of the two reciprocals. The chief object is to combine the Blackarm and wilt resistance and high ginning percentage of B.181 with the good lint of B.P.52.

Very few new selections were available and none of them proved very satisfactory.

A large number of new importations were grown this season and a fairly comprehensive collection of material has been got together which includes a few perennial cottons from different parts of the world.

Variety Trials.—The main variety trial was at Kawanda; it included seven varieties arranged in a Latin Square. It was sown at a spacing of

3′×1′ on June 29th, 1939. Germination was poor owing to the dry weather, and the plants remained smaller than usual. The results are tabulated below :—

Variety.	*Lb. seed cotton per acre.*	*G.O.T. %*	*Lb. lint per acre.*	*Blackarm lesions per plant.*	*Percentage plants infected with wilt.*
B.181	1,667	31·3	523	0·75	7·4
X (a mixture)	1,581	32·4	515	2·78	9·9
X.3 (a mixture)	1,532	31·5	483	3·45	11·2
B.P.52	1,477	31·1	460	4·84	15·6
Local	1,453	29·7	432	1·34	23·6
B.P.79	1,339	31·4	421	4·65	27·8
B.P.50.S.6	1,313	31·9	420	4·69	30·0
Least significant difference ...	230	0·7	—	1·76	14·0

Key to the varieties :—

B.181.—A Selection from Local.
X.—A mixture of S.G.23.8, B.P.52, and B.P.79.
X.3.—A mixture of 75 per cent. B.P.52 and 25 per cent. B.181.
B.P.52.—A Nyasaland Upland derivative.
Local.—The local seed planted in Buganda.
B.P.79.—A derivative of B.P.50, which came from Local.
B.P.50.S.6.—A slection from B.P.50 made at Serere.

The high correlation between yield per acre and percentage of plants attacked by wilt is of interest.

District Variety Trials.—4×4 Latin Squares containing Local, B.P.52, B.181, and X.3 were laid down at ten centres scattered over Buganda. On the whole yields were lower than in the previous season. Over the ten trials B.P.52 gave a slightly lower yield of seed cotton per acre than Local, but owing to its superior ginning percentage it averaged more lint per acre than Local. X.3 gave yields of seed cotton and lint per acre similar to B.P.52. B.181 again gave the highest yields, although, probably due to the dry weather and the lateness of this variety, its superiority in this respect was not so marked as in previous seasons.

District Variety Trials.
Yields in Lb. of Lint per Acre.

Centre.	*Variety.*				
	Local.	*B.P.52.*	*B.181.*	*X.3.*	*Mean.*
Kawanda	432	460	623	479	474
Bukalasa...	410	399	457	441	427
Kalagala	430	386	511	466	448
Nakifuma	304	395	410	385	374
Mukono	387	397	378	392	389
Kabasanda	475	491	514	385	466
Nkozi	309	379	313	364	341
Kalungu	154	129	175	101	140
Kyanamukaka	276	290	305	292	291
Bukomero	354	361	361	373	362
Means	353	369	395	368	371

Increase Plots.—A 1/10th acre plot of B.P.206—derived from B.181—was grown at Kawanda. Although sown very late it yielded at the rate of 580 lb. per acre of seed cotton and gave a ginning percentage of 35. A ½-acre plot of B.356—derived from B.P.52—was

also grown at Kawanda and yielded 940 lb. of seed cotton per acre. This strain appears to be rather less susceptible to Blackarm than its parent B.P.52. Five acres of X.3 were grown at Bukalasa. This is a mixture which originally consisted of 75 per cent. of B.P.52 and 25 per cent. of B.181. Yields ranged from 1,976 lb. per acre for the June-sown, down to 520 lb. per acre for August-sown. This mixture will be planted on the Kawanda Seed Farm in 1940–41.

Three acres of the mixture X(B.P.52, S.G.23/8 and B.P.79) were also grown at Bukalasa and gave good yields.

Kawanda Seed Farm and Segregated Area.—For the second year in succession the variety B.P.52 was distributed to the tenants. As the result of intensified propaganda for close spacing, the average spacing improved from 12 square feet per plant in the previous season to 5·5 square feet per plant and 7·7 square feet on the seed farm and segregated area respectively. The average for Kyadondo County in this season was 12 square feet per plant and it was chiefly on account of this great improvement in spacing that the seed farm and segregated area averaged 746 lb. of seed cotton per acre, as compared with an average of 443 lb. per acre for the whole of Mengo. The whole crop was purchased by the Department and ginned in the new ginnery at Kawanda. The crop totalled 154,229 lb. of first quality cotton and ginned out at 31·6 per cent. The Local crop averaged less than 29·5 per cent. ginning out-turn in the rest of Buganda. Pool prices were paid for the crop and the grade was excellent ; the growers appeared to be very satisfied with the results of their season's work.

The new ginnery, which has been provided through the generosity of the E.C.G.C., is driven by electricity, being the only one of this kind in Uganda ; it is equipped with a Platt's Single Opener, one Platt Single Acting Roller-bearing Single Roller Gin, and one Double Roller Middleton Gin. There is also a hand press for half-pressed bales.

Spinning Tests.

As in previous seasons, tests were again carried out on a series of lint samples through the courtesy of the Empire Cotton Growing Corporation, the Shirley Institute, the Indian Central Cotton Committee, and the Indian Technological Laboratory. Little new arose from these tests as they all confirmed the superiority of B.P.52 over Buganda Local. It is, however, surprising that the appearance of yarn from B.P.52 was not so good as that from either Local or B.181, especially at 64's count. The reports on B.181 are better than expected as they show that this variety produced yarns quite as good as Local.

SHIRLEY INSTITUTE RESULTS.

Variety.	Where grown.	Count × Strength.		Highest Standard Count.	Valuation Feb. American 7·84d.
		50's.	64's.		
Local	Bukalasa	1981	1732	48	90 on
B.P.52	,,	2370	2150	73	200 on
B.181	,,	1988	1748	49	80 on
B.P.116	,,	2371	2184	77	—
X.	,,	2430	2108	70	—
Local	Mukono	2014	1819	50	70 on
B.P.52	,,	2305	2141	74	225 on
B.181	,,	2125	1956	60	80 on

NOTE :—B.P.116 is derived from B.P.52.

INDIAN TECHNOLOGICAL LABORATORY RESULTS.

Variety.	Where grown.	Count × Strength.			Highest Standard Warp Count.	Value above contract rate of Rs. 280/–.
		30's.	40's.	50's.		
B.P.52	Kalungu	2,132	1,856	1 583	47	Rs. 131/– on
B.P.52	Kabasanda	2 316	2,125	1,752	54	Rs. 124/– on
Local	,,	1,966	1,755	1,579	46	Rs. 117/– on
B.181	,,	2,018	1,750	1,624	47	Rs. 117/– on

It will be noticed that at Kalungu, where very dry conditions prevailed, B.P.52 gave very poor spinning results.

ENTOMOLOGY.

Although *Lygus* was present in small numbers, no serious damage was recorded through this or any other insect pest.

MYCOLOGY.

Because of the dry conditions Blackarm was never serious and it was a matter of some difficulty to determine the relative resistance of the various strains.

As in previous seasons, considerable attention was paid to resistance to wilt ; this includes both *Verticillium* and *Fusarium* wilts which are indistinguishable from each other in the field. A heavily infected plot at Bukalasa was again utilised and this confirmed the resistance of the B.181 group and the susceptibility of the B.P.50 groups. B.P.52 appears to be intermediate between these two groups.

The comparison between B.P.52 and Local gave conflicting results at different places. For example, in the Kawanda variety trial B.P.52 gave less infection than Local, although this difference was not statistically significant. At Bukalasa two trials for wilt resistance were carried out ; in one, Local showed only 7·8 per cent. plants infected to 39·8 per cent. for B.P.52, and in the other trial Local gave 49 per cent. infected plants as compared with 22 per cent. for B.P.52.

As far as can be ascertained at present, plants showing internal symptoms only do not appear to suffer any appreciable loss of crop, whereas external manifestation of the disease reduces the crop considerably, and in the worst cases results in death of the plants. The B.181 groups shows very high resistance for the external type, but only relatively low resistance for the internal symptoms.

Summary.

Another abnormally dry season resulted in a slight reduction of yields. Heavy rains during the end of the picking period caused some loss of crop and reduction in the grade of the seed cotton picked at the end of the season.

The efficacy of close spacing and early planting was again demonstrated very forcibly.

B.P.52 remained superior to Local in the quality of its lint and in its spinning qualities, although the differences between the two cottons was not so pronounced in the very dry areas. Although it is probable that B.P.52 gives a slightly lower yield of seed cotton than Local, the superior ginning percentage of the former more than counter-balances this small apparent inferiority. B.P.52 does, however, remain suspect in its susceptibility to Blackarm.

B.181, although not liked by the brokers, gave yarns as good as Local. It is definitely superior to Local and B.P.52 with regard to ginning percentage, resistance to Blackarm and resistance to wilt. Its chief faults are its lateness and its short staple. Back-crosses between B.181 and B.P.52, doubling the B.181 dose, have given some very promising material.

The low ginning percentage of Local has once more given cause for considerable concern.

The seed farm and segregated area at Kawanda again proved to be satisfactory.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1940-41.

Agriculture.

Cotton Sowing Date Trial; Kawanda—Omitted.

Cotton Seed and Green Manure Trial; Bukalasa—To continue.

Soya Beans; Kawanda—Trials to continue.

Cotton Genetics and Breeding.

Pedigree Lines.—Further selection from B.181 in an attempt to improve lint qualities of this strain. Selections from B.P.50 to improve wilt and Blackarm resistance.

New Selections.—From Buganda Local and B.P.52.

Crosses.—F_1, F_2 and F_3 generations of B.181×B.P.52. Also back-crosses of the same two strains.

New Introductions.—An extensive series of cottons from various countries for observation and acclimatisation.

Museum Plot.—Collection of old introductions and some interesting local types.

Perennials.—A permanent plot of perennials, chiefly New World types, will be established.

Variety Trials.

(i) *Kawanda.*—7×7 Latin Square. Varieties:—Local, B.P.52, B.181, N.17M2, X., X.3 (39/40) and X.3 (40/41).

(ii) District Trials.—4×4 Latin Squares at 10 centres. Varieties: Local, B.P.52, B.181 and X.3.

Increase.

Kawanda.—$\frac{1}{4}$-acre B.P.213 (from B.18).

Kawanda.—1 acre X.

Kawanda—20-acres. Omitted.

Kawanda Seed Farm and Segregated Area.—X.3 (about 284 acres).

Bugerere.—B.P.52 (about 4,000 acres).

East Kyagwe.—B.P.52 (about 16,500 acres).

Bukalasa (all plots).—B.P.52.

Food Crops.

In addition to soya beans, collections of various varieties of sweet potatoes, yams, maize and cassava to be maintained.

SERERE ZONE.

BY
J. D. JAMESON.

Introduction.

The season was the driest on record and yields were even lower than in the previous year. Nevertheless early planting and the realisation of sounder principles in cultivation redeemed the position at Serere and the season's work proved very satisfactory.

Meteorology.

The total rainfall in 1939 was 36·94″, the average for 18 years being 54·41″ and the previous lowest 43·10″ (1921). The first rains were below normal except in May, when they were just normal. The second rains failed altogether except for two heavy showers in November (3·66″ fell on the 16th) which put the November fall well above average. In short, 1939 was a very difficult year.

The native grain crop was late owing to the uncertain rains, and native cotton planting was delayed in consequence. In spite of this the cotton harvest was decidedly early. At Serere, where planting was not delayed, the early sowings ripened off completely in November and December, and there was practically no top crop.

Agriculture.

Observations on development, diseases, pests and quality were extended to all manurial trials with most interesting results.

Manurial Trial.—The third cycle opened with cotton after green manure (*Mucuna*). Growth on plots manured with farmyard manure was much more vigorous. Blackarm was more prevalent on plots treated with lime. Yield responded to farmyard manure, but not in proportion to the amount applied, suggesting that manure in excess of 10 tons per acre (or some lower figure) did not become available in such a dry season. Seed weight, lint index and lint length were all increased by farmyard manure, but the increase in seed weight was greater than that of lint index, so that ginning percentage was reduced. Samples of lint have been sent for spinning tests and the different lots of seed have been planted in a small subsidiary trial for comparisons of germination, development, yield, etc.

Cotton Seed and Meal Manurial Trial.—This experiment is designed to test the value of cotton by-products as manure, viz. : the seed itself ; meal made from the cake left after decorticating the seed and expressing the oil ; and the vegetable plant residues, both unburnt and burnt.

Blackarm decreased with increasing levels of manure. It was also lower on the plots where the plants from the previous cotton crop had been burnt and the ash scattered. Soil analyses by the Senior Chemist showed that potash and phosphate were increased by manuring, more particularly by meal. Other elements were not affected. There was also a significant correlation (negative) between Blackarm and potash. Plant size and yield responded to manuring, but in each case meal and not crude seed was responsible. Plant size also responded to the burning of plants from the previous crop. Meal increased the seed weight and both manures depressed ginning percentage. A subsequent crop of *Eleusine* millet gave a very large response to the residual effects of the manures, particularly meal. Another experiment is being started to test the value of seed and seed ash, the latter being more economical in preparation and in transport.

Fertility Experiment.—This experiment is designed to test a variety of rotations and resting periods with applications of farmyard manure in the second year at the rate of 0, $2\frac{1}{2}$ and 5 tons per acre. A response in the yield of cotton was detected at $2\frac{1}{2}$ tons.

Interplanting Experiment.—The interplanting of bunch type groundnuts in cotton was not successful in such a dry year.

Genetics and Breeding.

Selection Plots.—No special distinction was made between pedigree lines, new selections, etc., and the restriction to formal rows of 25 or 50 plants was removed. Each strain was laid out in rows of 25 plants up to the limit of the seed supply. The maximum was 200 plants. After two months' growth single plants were selected by eye and staked. Flower-tying, harvesting and laboratory examination were confined to these plants, but routine observations on diseases and pests were continued over the whole mass of the material. In certain more attractive strains additional plants were staked for flower-tying in order to raise special bulks of seed. The change meant sacrificing detailed progeny analysis, but it had several advantages, viz.: greater scope for selection owing to the greater mass of material; increased selectivity, because the material was first sifted in the field and then again in the laboratory; reduced labour in flower-tying; and the elimination of thriftless material from laboratory examination.

These plots contained :—

(*a*) Derivatives of Nyasaland Upland: N.17, S.G.29, Nariama strain, and S.G.29 hybrid.
(*b*) Derivatives of U.4.4.2.
(*c*) Derivatives of Buganda Local: B.P.50, B.181 and Buganda Mass Selected (Serere selections from Bukalasa bulk seed).
(*d*) Derivatives of Cambodia.

In addition a number of new introductions and hybrids were grown on these plots for acclimatization and observation :—

(*e*) Serere hybrids and parents.
(*f*) Hybrid series from Nyasaland.
(*g*) Strains from America commercially resistant to *Fusarium* wilts.
(*h*) U.4. series received from Barberton in 1938.
(*i*) U.4 series received from Gatooma in 1938.
(*j*) Meade, S.G.85, and Pump Scheme strains from the Sudan.
(*k*) Strains from Russia.

Variety Trials.—At Serere six varieties were tested, each at four sowing dates and three spacings, as in the five previous seasons. The yields of first quality lint in lbs. per acre were :—

S.G.29 (control)	63
S.P.93 (Nariama strain)	60
N.17.M2 (mass selection)	77
S.P.102 (ex S.G.29 hybrid)	87
B.P.50.S6 (ex Buganda)	99
S.P.84 (ex U.4.4.2)	104
Significant Difference	5

In the district variety trials S.G.29 was beaten by S.P.84 and N.17.M2, but not by S.P.102, which was a failure. N.17 bulk, on the other hand, was not beaten either in Busoga or in the northern area. In Busoga S.P.102 was below N.17 bulk, and B.P. 52 was neither at an advantage or a disadvantage, except that it had more Blackarm than any other variety.

Seed Multiplication.

3-acres	re-selected S.P.84
40-acres	not cultivated
400-acres	S.P.84
4,000-acres	
30,000 acres	

It was not thought prudent to distribute S.P.84 throughout Teso District as a whole, and, as the performance of S.G.29 has been very poor of late, seed of N.17 bulk from Busoga was brought back for planting in 1940.

Spinning Tests.

Samples of the 1938–39 crop were submitted to the Shirley Institute and the Indian Central Cotton Committee. Both reports were favourable to N.17.M2, and N.17 bulk seemed to have a slight advantage over S.G.29. The reports on S.P.84 dropped sharply. 1938–39, like 1939–40, was an unfavourable season.

Entomology.

The Entomologist has concentrated his work on the major problem of *Lygus*, including physiological aspects of the problem, but it is still too early to say in what direction this work will ultimately lead. Pests generally were reduced to a very low level by the failure of the second rains, but the incidence of Pink Bollworm was high towards the

end of the season, so all cotton was uprooted and burnt at the earliest reasonable date. The crop ripened very rapidly and an unusually long close season was achieved.

Mycology.

Blackarm naturally was at a very low level, and it is now ten years since Blackarm reached epidemic proportions. Sure progress in selection away from Blackarm has been difficult to achieve under these conditions, and the possibility of spraying selection plots is being considered.

It has been noticed for some time that new strains are very prone to lose their apparent resistance when they reach cultivation on a field scale, and some doubt is cast upon the advisability of continuing self-pollination over an extended term of years.

A further difficulty has been the assessment of the degree of attack when there is much variation in plant size. This season S.G.29 was very stunted whereas N.17.M2 achieved more vigorous growth than any other variety. As a result N.17.M2 was debited with a high lesion count whereas the degree of attack was obviously less than on S.G.29. The trouble is even more obvious on manurial trials, where plant size is strongly influenced by manures. Attempts have been made to correct for plant size by weighing uprooted plants at the end of the season, but sampling difficulties have arisen and there is also no unity of time.

Finally, the seed for variety trials is inevitably drawn from a number of different sources, and so carries different amounts of primary infection. A new technique is being developed which aims at correcting for primary infection and for plant height at the time the lesion counts are made. This is being done in consultation with the Senior Plant Pathologist who developed the original technique.

Summary and Conclusions.

The season was the driest on record.

Work on manurial trials was extended with interesting results.

The method of selecting single plants was revised and certain practical advantages were gained.

N.17 bulk and N.17M.2 have again done well. The latest spinning reports on S.P.84 are not so satisfactory.

Work on *Lygus* is still in a formative phase.

Blackarm technique is being revised.

TANGANYIKA TERRITORY.

PROGRESS REPORTS ON COTTON WORK 1939-40.

INTRODUCTORY NOTE

BY

THE DIRECTOR OF AGRICULTURE.

Throughout the season the three cotton experiment stations at Ukiriguru, Lubaga and Kingolwira were in charge of officers seconded by the Empire Cotton Growing Corporation. The reports give a valuable assessment of the present position regarding cotton breeding on each of the stations and they indicate the necessity for more intensive breeding work and the direction in which this work should proceed.

Trials with Egyptian cotton in the Rufiji have been stopped and Zombe Experiment Station has been closed down as the station was opened principally to test Egyptian cotton varieties.

The growing season at both Lubaga and Ukiriguru was generally good while at Kingolwira favourable planting rains were followed by dull cloudy weather which seriously affected the yields of clean cotton in the experimental plots.

Experiments connected with soil fertility and manuring were an important part of the programmes on the stations. Some new experiments on the interplanting of legumes and with green manuring crops were started at Ukiriguru to find out how far soil fertility can be raised by these methods which, however, to be successful must be practicable for native growers. At Ukiriguru and Lubaga new areas of land have been broken to provide larger areas of important soil types. The lower lying " mbuga " lands at Ukiriguru which are unsuitable for growing cotton will no longer be used for this purpose.

A considerable amount of work has now been done on native food crops and many of the experiments connected with the testing of varieties has been completed and sufficient knowledge acquired of their comparative values under different conditions. Many of these variety trials will now be stopped which will permit of more time being given to work on cotton and soil fertility. When it is desired to try out new or improved varieties of food crops this will be done on the experiment stations. The valuable work which is being done at the Mwabagole rice plot on rice varieties, methods of planting and spacing will be continued.

The cotton season was characterised by severe jassid damage on all the stations and an opportunity was thus provided of sorting out strains which did not show jassid resistance. Jassid attack was largely responsible for the appreciable reduction in yield of the bulk crop in the Lake Province and officers in charge of the experiment stations have all drawn attention to the substantial reductions in yield brought about by lack of jassid resistance in our cottons ; they regard jassid resistance as one of the most desirable characters for which to select new strains. On all stations the material within which to select appears to be ample.

The two strains, 561 and 457, which were selected at Ukiriguru and are now being bulked for general distribution gave comparatively very high yields in the Uzinza area ; native growers in this area have been quick to appreciate the fact that these strains give higher yields than ordinary Local and they now insist on receiving seed of the improved strains. At Ukiriguru strain 457 showed poor jassid resistance.

Observations on the behaviour of the Gatooma selections which were planted are interesting and indicate that these strains were not affected much by their change of environment.

The breeding work at Kingolwira is being reorganised and requires very considerable attention. The station is newer and the work has not progressed as far as it has done at Ukiriguru and Lubaga. It will be more difficult to evolve a type of cotton suitable for general distribution at Kingolwira as this station serves a wide area with very much more varied conditions of weather and soil than are found in the Lake Province.

Attention is also drawn to the increased yields which could be obtained by native growers if closer spacing were adopted in the drier areas. Time-of-planting experiments again demonstrate how very important early planting is in order to obtain maximum yields.

The settlers at Nyamahona and at Kingolwira had a fairly good season, but on the latter settlement soil fertility problems are now becoming prominent and emphasise the necessity of introducing cattle to the settlement at an early date and draw attention to the primary importance of solving the tsetse fly problem locally before any settlement based on mixed farming practices can be regarded as permanent.

UKIRIGURU EXPERIMENT STATION AND FARM, AND MWABAGOLE RICE STATION.

PROGRESS REPORT FOR THE SEASON 1939-40.

BY

J. E. PEAT.

Introduction.

This is the first Ukiriguru Progress Report written by an officer of the Empire Cotton Growing Corporation, seconded temporarily to the Tanganyika Department of Agriculture. It is inevitable and it is desirable that the work so far undertaken and the results achieved should have been reviewed. Such amendments to the programme and suggestions for future work as have been made have been made with the goodwill and co-operation of those who have been most concerned with the development of Ukiriguru, and after many discussions as to how the improvements desired might best be achieved.

Firstly, it is suggested that, for the present at least, the work of the Station be concentrated on a few main problems :—

(*a*) Fertility work for the lighter lands.

(*b*) Some measurement of the values involved in rotation.

(*c*) Cotton selection and testing.

(*d*) Elementary survey work on *Striga hermonthica*, a serious parasite on sorghum in much of the area.

(*e*) A continuation of the rice work.

It is proposed to use the main, older, portion of the farm, the lower lands, as the seed farm, for which financial assistance from the Native Authorities is obtained, for the bulking of groundnuts, maize, small quantities of millet, and small quantities of the more interesting sorghum varieties, for distribution to the people.

Previous work has shown the unsuitability of these lower lands for the growing of cotton. There are special difficulties in the deep, heavy, mbuga soil because of *Lygus* damage. The land lying between the mbuga and the ligher hill land is underlain by heavy impermeable soil, 6″ to 18″ under the surface. Most of the cotton grown there this past season was waterlogged, and a complete failure.

It is therefore proposed to transfer all the cotton, and indeed most of the present experimental work, to the deeper, lighter, hill land. In the past there was only a very small amount of this land available. An area added last year and hurriedly prepared for use this past season is new and still fairly irregular. This has interfered with the

experimental results there and has meant high errors. Wash on the imperfectly levelled land also added to the difficulties. Because of the slope, this land has to be laid out with care. (All cultivation is on the ridge, and slight ridge-tieing is practised.) There is still insufficient deep light land of this type at Ukiriguru, and when fuller work can be undertaken a further area is very necessary for large-scale fertility trials, rotation work, and the first stages of cotton strain multiplication.

A considerable amount of time since July has been taken from the work of the Station by cotton ginnery control and marketing work arising out of the Government control of the Lake Province cotton crop.

Meteorology.

Though it has been a wet season, cotton planted early and on suitable land has suffered little, but cotton on the low lands suffered from waterlogging. The rainfall for the period October–June, both inclusive, was 37·75 inches. There were showers in mid-November, which germinated seed planted by then ; the remainder of November, and all December, however, were dry. This hit most of the Station cotton, which for a number of reasons was planted after mid-November. The rainfall from the beginning of January, 33·15 inches, was very heavy for this area.

Most of the cotton which germinated by mid-November was fairly good ; but much of that which germinated in January seemed to be slow in getting away. The later planted cotton on the hill soil was fair ; while the later planted cotton on the lower lands was very poor. The best early-planted cotton gave a yield of 900–1,000 lb. seed-cotton per acre ; the later planted cotton on the hill soil gave about 400 lb. per acre, while the yield from much of the later planted cotton on the low land scarcely reached 100 lb. per acre.

Agriculture.

Time of Planting.—The value of early planting of cotton around Ukiriguru has again been demonstrated clearly this year. Early planting is a very important factor in obtaining better yields ; and probably will be even more so when jassid-resistant strains are available. The results given below illustrate what was happening under unmanured hill-soil conditions. The results from the last plantings are scarcely fair, however, as jassid from the earlier-planted plots bombarded them to an extent greater than would have occurred in practice in the field.

Time of Planting.	*Mean Yield of Seed-cotton in lb. per acre.*
October 1st	531
October 15th	700
November 1st	923
November 15th	852
December 1st	482
December 15th	274
January 1st	90
January 15th	41
February 1st	12

Difference for Significance (P = ·05) = 207 lb. per acre.

Fertility ; Manuring ; Rest and Cover Crops.—It is on the lighter hill lands that the need for work on fertility is greatest, and it is only a matter of time before the results of such work will have to be applied to the not dissimilar Lake shore sands, if indeed in many areas it is not already necessary, and in the same way to the newer developed areas at present at a satisfactory level of fertility. This testing and assessing of possible methods of increasing the fertility of such soils is probably one of the most important functions of Ukiriguru.

As a result of the experience gained, it would appear that under present conditions the best approach to the problem of improving the native food crop position would lie in improving soil fertility and in rotation, rather than in improved seed supply. None of the tested millets, sorghums, and groundnuts is a marked improvement on, or a completely satisfactory substitute for the native stocks at present grown.

The use of manure where available, must be the first step, and will probably be used in association with any rest and cover crops.

This year, application to the hill soil of 5 tons per acre of manure or compost, has meant an increased yield of millet up to about 70%, with the unmanured millet yielding 800–1,000 lb. per acre ; and an increase up to between 50% and 70% for cotton. The cotton yields were mainly on a low level plane, partly owing to the fact that much of it was planted after the mid-November showers, and partly to soil difficulties. This work will have to be continued. The best results appear to be from applications of farmyard manure made under cover : but in native practice this would most likely be difficult to get, and probably very much larger quantities of a type of compost, could be made nearly but not quite as effective. At Ukiriguru considerable quantities of simply made compost and pen manure are being made in open " bomas " on the hillside.

In the second year effect trial, following a 3 tons per acre application in 1938–39, there seems to be about a 35% increase in yield of millet, and about a 25% increase of cotton. Next season's results should give more accurate figures.

A number of experiments have been laid down on the inter-planting of legumes in millet. The most interesting is possibly the inter-planting of the Ukara legumes, *Crotalaria* spp. and *Tephrosia* spp. These in no way reduce the current yield of millet. There is even a suggestion that with such inter-planting the immediate millet yield is increased. The inter-planting of pigeon pea, however, does have a reducing effect on the millet yield. Next season's results, following the digging-in of such inter-planted cover crops, will have to be awaited. The results this year are inconclusive, because of plot difficulties.

Such crops, in addition to providing humus when dug in, provide a certain amount of soil cover through the dry season. In the island of Ukara, where *Crotolaria* and *Tephrosia* are in general use in this way, the ground is manured before planting ; the cover crop thus gets a better chance to get away. This has not been done so far at Ukiriguru, but it will be done this coming season, and on a practical scale on the cultivators' own shambas, with the co-operation of a few natives around.

At Ukiriguru rotation experiments have been started : the main one is a rotation of cotton and millet, with the effects of various treatments on them.

The resting crops so far laid down are pigeon pea, elephant grass, and two other grasses. The elephant grass, even on the hill soil, was easily established, and under the conditions of the year grew satisfactorily. It remains to be seen how easily it can be established, and how it will fare, in drier years.

Spacing.—It is felt that better stands, and closer spacing of cotton, will do much to raise yields. But while the closer spaced cotton at Ukiriguru this year gave the highest yields, the results are not as striking as was expected. Strain 561, a fairly vigorous type, was the strain used, and soil irregularities (old grass paths, etc.) chanced to favour, by stimulating growth, some of the widest spaced plots. Further work on this is necessary : and if sufficient ground can be spared, a spacing trial will be made with a jassid-resistant U.4 type, as well as with 561. In the observation plots proposed for the area served by Ukiriguru the strains to be tested will be grown at a close as well as at the normal spacing. These plots will cover a range of conditions.

Again this season, which was a good year for rice, the close spacing of rice and sorghums has given the highest yields. The rice yields, both at Mwabagole Rice Station and on dams at Ukiriguru were high—up to 2–2½ tons of paddy per acre. A considerable quantity of seed of the two chief varieties, Afaa and Maji Maji, is being distributed to the

people. Selection work should be worth while, and a few of the newer introductions are worth following up.

The ordinary native millet yielded in trials as well as the other varieties tested, and it has better keeping qualities.

There did not appear to be the reduction of *Striga hermonthica* following manuring, that is reported with *Striga lutea.*

Breeding.

At Ukiriguru and in many areas jassid damage has been heavy, whereas in other areas it has been negligible. On the farm and in the neighbourhood " Local " cotton in bulk suffered heavily, and mainly as a result of this, yielded very poorly. In other districts where jassid attack was negligible and on good soil " Local " has surprisingly yielded fairly well. It is not naturally a productive variety.

At and around Ukiriguru, strain 561 has put up a fairly good show. Two selections from it, 561/2, and 561/6, are worth continued attention. At Ukiriguru, 457 with its poorer jassid resistance and less vigorous habit, did not look so well, but at Uzinza, where it was being bulked on better soil and under easier conditions, it cropped well.

None of these strains as they stand is good enough ; and to be safe a high degree of jassid resistance is desirable.

The better U.4 lots did well, especially those with a high degree of jassid resistance. Some of the heaviest fruiting lots seem to lack hardiness, however, and did not finish well. The best U.4 lots, hardy and jassid resistant, will have to be continued and tested ultimately against the best of the jassisd-resistant Mwanza material. There appears to be little difference in lint length between the latter and the best U.4's ; the main difference lies in the silkiness of the Mwanza lint and the slight roughness of U.4.

It is interesting that the U.4 strains brought from Gatooma behaved more or less as they had behaved there ; the best Gatooma strains were the best performers at Ukiriguru. The qualities of good jassid resistance, hardiness, and good finish, with the best lint and ginning percentage possible, which have been receiving attention at Gatooma, are qualities of importance at Ukiriguru in a season such as the past.

A considerable number of selections have been made from the Mwanza strains, " Local," and the U.4 lots : all are jassid-resistant, and were behaving well under the conditions of the year. Some useful strains should result.

Strain 561 bulked on the native shambas around Ukiriguru, and 561 and 457 that are similarly being bulked at Uzinza cropped much better than the standard " Local " Mwanza cotton nearby ; so much so

that the natives in both areas have asked very definitely for the same type of seed again. Yet, in the trials at Ukiriguru, such marked differences did not show up. The most jassid-resistant Mwanza strain, 570, gave the highest yields ; 561 and 457 yielded better than " Local," but not so outstandingly as was expected, nor as strikingly as in the bulks and in the bulking areas. Only in a trial in the mbuga, where *Lygus* attack was crippling, did " Local " show a marked drop compared with the others.

STRAIN TRIAL.

Strain.	*Mean Yield of Seed-cotton in lb. per acre.*
570	505
561	444
457	431
Mwanza " Local "	412
655	375
613	274

Difference required for Significance (P = ·05) = 69 lb. per acre.

VARIETY TRIAL.

Variety.	*Mean Yield of Seed-cotton in lb. per acre.*
561	384
457	358
Mwanza " Local "	325
S.P.20 (U.4/4/2 Origin)	270
998 (U.4/4/10 Origin)	228

Difference required for Significance (P = ·05) = 63 lb. per acre.

This coming season, " Local," 561, 457, and a good hardy jassid-resistant U.4 will be grown throughout the area in observation blocks. A range of conditions will be covered.

Two considerable areas in Western Mwanza will be under improved cotton, one area under 561, and the other under 457. About two hundred tons of seed are available.

ENTOMOLOGY.

Jassid.—As mentioned above, at Ukiriguru and at other places throughout the Province jassid damage has been severe and has reduced very materially the yield from such jassid-susceptible cotton as Mwanza " Local." In other places the damage has been negligible. Around Ukiriguru the degree of attack was about as bad as anything seen in Rhodesia or South Africa. Only the most resistant strains stood up to it. Moderately resistant strains suffered as they did in Rhodesia. To be safe, a fairly high degree of jassid resistance will be necessary.

Lygus.—On the low-lying mbuga land, *Lygus* attack, on top of jassid, was crippling. Little damage was seen on the higher lands, nor was anything like the same extent of *Lygus* damage seen elsewhere in the Province.

A measure of *Lygus* resistance seems to be associated with hairiness. The better response of highly jassid-resistant U.4's under mbuga conditions supports this; and the fact that, though yields were low, 570, a moderately resistant Mwanza strain, yielded at nearly twice the rate of "Local" in the mbuga trial.

Bollworms.—There was a smallish amount of American bollworm loss; (it was heavy at Uzinza, under a system of early maize planting with the first rains, and a growing of early Dolichos). It is understood that pink bollworm took a toll of the top crop on Ukerewe Island, but this was not seen personally.

Stainers.—Stainers were not bad at Ukiriguru, though serious in areas further South. *D. superstitiosus* and *D. nigrofasciatus* were late in coming into the crop, followed later by *D. fasciatus*, and *Callidea* spp. *Callidea* was present in comparatively large numbers towards the end of April and in May; but as late in the season as this little damage seems to have resulted.

There is heavy breeding of *D. fasciatus* around ginneries, ginnery wharfs, and some seed issuing centres. There is some evidence that crops near such centres are more heavily populated with *D. fasciatus* in consequence, and it would be well at the end of each season to have such centres of breeding cleaned up thoroughly.

Mycology.

As has been mentioned, much of the cotton, especially on the lighter hill soil, which struggled through in December or which did not germinate until January hung fire in the early stages. This interfered with the stand in some of the trials. Leaching of nitrogen may have played a part, but secondary fungus attack was also probably at least partly responsible—possibly *Rhizoctonia*.

Summary and Conclusions.

The value of early planting of cotton around Ukiriguru, as early as good rains permit, has again been shown clearly. A marked delay in planting means a big falling off in crop yield.

The results of the year have shown the importance of getting cotton out of the valley bottoms on to deeper, though lighter, higher lands.

The value of manuring on such lands has been shown both for grain and cotton. Preliminary experiments have been laid down to prove the value of rotation, and others to test various methods of improving fertility, the inter-planting of cover crops in millet, and resting crops. This side of the work must be one of the most important functions of Ukiriguru.

For cotton, the necessity for good jassid resistance was very clear for Ukiriguru and for at least several other areas in the Province. There exists also the necessity for a better yielding variety than "Local." 561 and 457 represent a step forward, although 561 is only moderately jassid-resistant, and 457 poor in resistance. Material of much higher jassid-resistance, more uniform, and heavier yielding, is urgently required. Here the better jassid-resistant U.4's will have to be tested against the most jassid-resistant Mwanza material.

Around two hundred tons of 561 and 457 seed are available for multiplication this coming season in two areas in Western Mwanza.

Close spacing for sorghum and rice has again proved to be the best. The heaviest cotton yields come from the closest spaced cotton, but owing to land irregularities the results are not as definite as was expected, and more work will have to be done on this. It is felt that closer spacing, and better plant stands, will help considerably in raising yields. This will have to be demonstrated.

Rice yields at the Mwabagole Rice Station were good. It was a good rice year. Considerable quantities of seed are being distributed. The variety trial results are more or less as in other years. Afaa and Maji Maji are the two varieties receiving most attention. Some of the newer introductions are worth following up.

PROGRAMME OF EXPERIMENTS, 1940-41.

The work on fertility, manuring, inter-planting, and rest crops, will be continued, and second and third year effects will be recorded. A new experiment will be started to measure the value of different simple manurial applications suitable to native practice—manure and compost, stalks, stalks plus a thin dressing of compost or manure, and very imperfectly broken-up pen manure (really the first stage in compost making).

Fresh areas of the Ukara legumes, *Crotalaria* spp. and *Tephrosia* spp. inter-planted in manured millet, will be tried. The co-operation of one or two natives on their own shambas around Ukiriguru is being obtained, in order to test this out also practically under their conditions.

Further areas of elephant grass and pigeon pea will be laid down, testing difficulties in planting and establishing, season by season.

The rotation experiments will be continued—cotton, millet, and treatments of these.

The selection and strain testing work will continue. Selections from Mwanza and U.4 cotton, mainly of good jassid-resistance, will be grown. The most promising of the material of this past year will be bulked, to obtain sufficient seed for further work. It is hoped that some small bulking will be done with the co-operation of one or two of the neighbouring natives on their own shambas.

A trial or trials will be carried out, using the " Local " cotton, 561, 457, and a hardy jassid-resistant U.4 type. Throughout the area observation plots of these strains will be grown, at normal and at close spacing.

Small observation plots of jassid-resistant Mwanza and U.4 types will be planted under mbuga conditions to note possible resistance to *Lygus*.

A further spacing trial will be carried out using 561 : if sufficient ground can be spared, there will be a second trial using hardy jassid-resistant U.4 material.

The value of early planting of cotton has now been abundantly proved, but demonstration plots will be continued.

Preliminary work on the severity of the attack by *Striga hermonthica*, the effect of manuring, etc., will be continued on a very small scale.

The value of close spacing both for rice and the sorghums has been clearly established, but demonstration blocks will be planted.

The rice multiplication work will continue in order to provide pure seed for issue. Selection work will be started, mainly in the variety Afaa. The best of the newer introduced varieties will be continued.

NYAMAHONA EXPERIMENT SUB-STATION.

PROGRESS REPORT 1939-40.

BY

B. R. D. ECCLES.

Introduction.

Farming operations were concentrated upon the lower " mbuga " and " semi-mbuga " soils, and on the upper sandy and sandloam ridge ; the original six blocks on the hillside were abandoned.

The whole of the " mbuga " area has now been divided into eighteen blocks which are demarcated by drains and hedges, while the whole area has been hedged in with sisal and euphorbia hedges.

The sandy ridge, which is close to the dwelling-house, gave very good yields of cotton during the 1938–39 season, and it was decided to extend it ; a total of 28·7 acres was cleared, levelled and planted. During the current dry season the whole of the remainder of this ridge has been cleared, giving a total of 62·4 acres.

Meteorological.

The early part of last season, with the exception of November, was comparatively dry and hot dry winds prevailed. From February to May conditions changed and exceptionally heavy rains fell.

The dry season has been exceptionally long this year and the weather has been hot and windy. Normally there are seldom more than two months without a good fall of rain, but this year from the middle of May to the end of September there were only 0·64 ins. of rain.

Agriculture.

More oxen were available this year and nearly all cultivation, including ridging, was carried out with ploughs, ridgers and cultivators. Not only were costs greatly reduced, but better results were obtained.

The use of more oxen reduced the costs of cultivation on one block from fifty-three shillings an acre in 1938 to twenty-nine shillings in 1939.

Most of the lands were ploughed during the dry season and allowed to lie fallow till planting commenced. All crops were planted as early as possible. All lands were cultivated regularly with cultivators and this greatly reduced weeding costs.

Cotton was planted in late September and yielded just over 1,000 lb. per acre of seed-cotton ; in the previous year the same block yielded only 420 lb. per acre. This substantial increase in yield is ascribed to earlier planting and the proximity of a block of maize which attracted American bollworm.

The value of the cotton spacing trial was nullified through uneven germination.

The yields of sorghums were poor because the crop was badly affected by the heavy rains.

Entomology.

The maize was again attacked by stalk borer and top grub (American bollworm). The stalk borer was checked by applications of Derrisol. A great deal of damage was also done by weevil which even attacked standing crops. Cotton was comparatively free from bollworm and the

yields showed a very marked improvement. During the later half of the season, capsid and jassid were prevalent though the infestation was not as heavy as in some years.

It should be noted that the American bollworm did not leave the maize in favour of cotton, but appeared to show a marked preference to the maize at all stages of growth ; maize was more infested than in any previous years yet the cotton was hardly affected at all. The high yield of cotton is attributable partly to the fact that the maize, which was planted in a contiguous block, was more attractive to the weevil.

Stainers were not noticeable this season and only affected the late cotton. Locusts did some damage to late maize.

Settlers.

There are now 303 adult male plot holders on the settlement and they with their wives and dependents make up a total population of 1,157. There are 516 cattle and 1,500 small stock. The cash earnings of the plot holders averaged Shs. 446/– from the sale of cotton and surplus food crops. The average earnings from the sale of cotton was Shs. 96/–, the price paid being 8 cents. per pound of seed-cotton.

Conclusion.

The year under discussion has been by far the most favourable for all crops except sorghums. The average cotton yield per acre was 615·9 lb. as against 337 lb. for the previous season. Maize yields averaged 1,004 lb. per acre, and would have been about double this figure had it not been for damage by locusts, top grub and weevil. Earlier planting of cotton and maize was a great factor in increasing yields.

Nearly all development work (building, stumping, levelling, etc.), is now completed.

LUBAGA EXPERIMENT STATION, SHINYANGA. PROGRESS REPORT, 1939-40

BY

A. N. PRENTICE.

Introduction.

The programme of work for the season was drawn up by Mr. King, who was in charge of the station until December, 1939. Full co-operation was maintained with Mr. King, who concentrated on

district work, and with the Agricultural Assistant, Mr. Glegg, who divided his time between the district and Lubaga, until both were called up for military service in mid-season. Station work started as planned, with a few modifications, and has been completed as far as possible.

Meteorology.

Weather variations were not extreme. Rainfall at Lubaga itself was 30·51 inches over the period November, 1939, to May, 1940. The distribution was good on the whole, but in February the less drought-resistant crops suffered during a dry spell of nearly four weeks. In the surrounding district rainfall was fairly good, but in some areas the February drought was more pronounced than at Lubaga. Local native opinion sums up the growing season in most areas as good.

Agriculture.

The main crops on the farm, cotton, maize, sorghums and groundnuts, were planted under good conditions in December, 1939. The total area under the plough was approximately 262 acres, of which 40 were under cotton.

This total includes some 10 acres of land, broken for the first time, at an extension site known as Butulwa, five miles from Lubaga. The Butulwa soil is a red medium loam, and is different from the friable, grey-black, calcareous loam of Lubaga. Both soils are well represented in Shinyanga district, but much of the cultivated area in Shinyanga is on poor or worn-out granitic soils, and these are not represented at Lubaga.

Lubaga is protected from grosser soil erosion by contour banks, and the land is in better heart than much of that in the district.

Maize and sorghum yields were variable, but poor on the whole, due partly to the February drought, partly to heavy infestation by witchweed (*Striga hermonthica*), and partly to heavy attack by stalk-borer.

Cultural Experiments.—Tie-ridging, virtually the making of small rain-holding pockets in the soil, gave heavier yields of both grain and stover than ordinary ridge, or flat cultivation. The superiority of the tie-ridging over other cultivation methods, shown in previous seasons, was generally evident in demonstration blocks of cotton and sorghum, although no significant results were obtained from trials.

The response to manuring was well marked in various demonstration blocks on the Lubaga black soil. On newly-broken red soil at Butulwa, maize showed a significant and sensitive response to farm-yard manure.

RED SOIL, WHITE CANGO MAIZE.

Rate of Application of Manure : tons per acre.	*Mean Yield of Grain in lb. per acre.*
0	1,037
1	1,205
3	1,587
5	1,945

Difference required for Significance (P=·05)=259 lb. per acre.

An adjacent trial on this red soil, with cotton and the same manurial treatments, gave yields of a low order on account of heavy jassid and stainer attack, but results were significant and the 3-ton treatment was appreciably better than the control (in the ratio 370 : 260, pounds seed-cotton per acre).

Much of the cotton grown in Shinyanga is on poor land. The yield over the whole district is probably of the order of 150–200 lb. seed-cotton per acre. On this poor land the spacing usually employed—an indefinite 3′ row with intra-row spacing of anything from a foot upwards, often with a single plant per hill—is obviously too wide for the conditions. Two trials to test spacings with high numbers of plants per acre were laid out on poor thin soil, the nearest that could be got on Lubaga to much of the district soil. They show the importance, under these conditions, of close spacing.

BLACK SOIL, POOR TYPE. 998 COTTON. ROWS 2′ WIDE.

No. of Plants per hill.	*Spacing between hills.*	*Plants per acre.*	*Mean Yield of Seed-cotton in lb. per acre.*
1	6″	43,560	271
2	12″	43,560	280
3	18″	43,560	269
2	18″	29,040	239
1	12″	21,780	222
1	18″	14,520	205

Difference required for Significance (P=·05)=32 lb. per acre.

The other trial gave similar significant results, and included a treatment representing normal native spacing (approx. 10,000 plants per acre) which was quite the lowest yielder of all treatments at 170 lb. seed-cotton per acre.

Cotton in Shinyanga is planted at various dates from December to March, with peak planting probably in January. Lubaga time-of-planting experiments over a number of years, including this year, have been used to show that December plantings outyield later plantings, and that, with the possible exception of cotton from plantings made at the earliest rains, the proportion of stained cotton increases progressively the later the planting date. Observations confirm both points. However, the design of the time-of-planting trial may not have been the best for the purpose, and further efforts to get exact information will be made next season.

Cotton Breeding.

The growing season was almost ideal for cotton. Stand and growth were good in all sections. No development records were taken, but the very high flowering rate was obvious. Yields, however, were not good. The drop from a heavy potential yield to the very mediocre actual crop was almost entirely due to insect attack. Strain differences, however, were marked, and much useful information was collected.

U.4/4/2 is the commercial cotton of Shinyanga. This is a very mixed stock, with a general low average of desirable qualities, and its replacement by the U.4 strain 998 was started last year. 998 itself will be only a stop-gap until the much better material now seen to be available can be sifted, tested and multiplied.

The main groups under observation at Lubaga this year were the older Barberton U.4's, some recent Barberton U.4's, a range of Gatooma U.4's and some Mwanza Local types.

Not enough seed of the Gatooma U.4's was available for variety trials, but in observation plots the group as a whole showed itself to be very well suited to its new environment; the Shinyanga climate—rainfall distribution, and temperatures during the growing season—is not dissimilar to that of Gatooma, but rather easier on the plant from March onwards, and the strains took full advantage of this while retaining their distinctive features as at Gatooma. Again, the type and intensity of insect attack—judging from previous Lubaga records, but personal experience of only one season—seems comparable in the two places, and the Gatooma U.4's, bred for adaptation to such an insect environment, showed up favourably in this respect at Lubaga.

Jassid attack on Lubaga was intense and prolonged. Strains suffered in varying degree, but the only strains that could be called unaffected were some of the Gatooma U.4×Cambodia backcrosses, and a Gatooma U.4, 7L.6, and its derivatives. Such strains were cropping and finishing appreciably better than adjacent susceptible strains. Many selections were taken out of these resistant sub-strains. The lint on first inspection is at least on a par with that of the present stock strains. Seed of these Gatooma U.4's will be available next season for testing in formal trials, as in spite of heavy insect (other than jassid) attack, the best Gatooma U.4's set crops of up to 750 lb. per acre seed-cotton.

In observation plots, and in a strain trial, the recent Barberton U.4, 6250, was outstandingly superior to all other Barberton types. The one desirable quality lacking is jassid resistance, and on this count, although fair, 6250 may not be good enough for local conditions. It is distinctively different in habit to the other Barberton strains, and

shows much better opening than the 052 types (of which 6130 showed particularly "sticky" opening). Ginning percentage was rather higher than in any other Barberton strain tested, and lint quality seems good. The trial mentioned included fourteen strains, the majority of which will be dropped in future, and only the more interesting are shown in the table below.

Black Soil. Spacing 3′×1½′.

Strain.	*Mean Yield of Lint in lb. per acre.*
6250 (Barberton U.4 Tracing to 921)	243
6130 (Barberton U.4 Tracing to 052)	190
Mz.457 (Mwanza Ukiriguru type)	180
5143 (Barberton U.4 Tracing to 052)	169
998 (Barberton U.4)	167
4/4/2 (Barberton U.4)	167
Mz. Local Bulk	119

Difference required for Significance (P=·05)=29 lb. lint per acre.

A very high standard of jassid resistance was set in the selection work. Over two hundred selections have been made, the majority from the Gatooma material, but fair numbers from the Barberton U.4 and Mwanza types, including "Local." From which group it will come cannot be foretold, but the chances are good of a type being isolated quickly that is much better than the local stocks.

A small "acclimatization" plot at Lubaga, planted with one strain of cotton, but with seed from three sources, is possibly worth mention. Seed of the strain 5143 was available from the previous year's crops of Lubaga, Gatooma and Barberton; this was planted in adjacent plots (not replicated). Observation throughout the season showed no differences between the "strains" which could not be ascribed to ordinary field fluctuation, and of the many visitors whose opinion was sought, none could see the slightest difference between "strains." The same remarks apply to a similar triple plot of 5149 cotton.

Entomology.

The feature of the year at Lubaga was the heavy and sustained insect attack on cotton.

Jassid.—Jassid (*Empoasca sp.*, presumably *E. fascialis*) was first noticed on six-weeks' old cotton at the beginning of February. The attack did not develop during the dry spell in February, and all cotton made good growth during this month. The March rains heralded the real attack on Lubaga which lasted without a break until it started to fade in May. The attack on cotton on red soil at Butulwa followed much the same course, and even a hairy malvaceous weed, probably an Abutilon, was badly crumpled by jassid. All strains of cotton on Lubaga, with the exception of one straight U.4 (7L.6 and its

derivatives) and some U.4×Cambodia cross material, suffered in varying degree, and only the ideal growing weather enabled the plants to mature what crop there was in the face of the attack. All parts of Lubaga suffered equally, with one notable exception : a corner of a field in which the soil broke from the usual black " ibushi " to a hard-pan or " ibambasi " suffered no jassid damage throughout the season. The change from jassid-struck to perfectly green plants in a distance of twenty yards was striking. The yield per acre from this corner was appreciably more than from the rest of the field, although the plants were much smaller.

Jassid attack in the district of Shinyanga on nearly all crops seen was lighter than at Lubaga, whether the crops were late or early and irrespective of soil type.

Nevertheless, a very high standard of jassid resistance is the first essential in any cotton meant for issue to the district.

Stainer.—Boll-sucking insects were numerous and did much damage. Five species of stainer were present, *Dysdercus fasciatus*, *D. intermedius*, *D. cardinalis*, *D. superstitiosus* and *D. nigrofasciatus* ; *D. fasciatus* was by far the most plentiful. Two species of *Callidea* made a sudden influx in mid-March and remained at a steady high level of numbers until they suddenly disappeared in early May ; a few nymphs mere seen on the cotton in April.

D. fasciatus was first noticed in numbers in March, and nymphs were first noted as boll-opening started, towards the end of March. The attack developed steadily all through April, but lessened from mid-May onwards. *D. nigrofasciatus* was not at all plentiful until late in the season. *D. intermedius* seemed unimportant. *D. cardinalis* was most obvious in April, although it was also recorded in June. *D. superstitiosus* was not actually observed in big numbers, but the circumstantial evidence of appreciable staining and boll-shedding among the earliest bolls (from February flowers) pointed to an unnoticed early visitation by stainer, possibly this species. Stainer attack was spread over almost all the farm, and did great damage to the crop.

Heavy staining in the south-west of Shinyanga was responsible for the virtual failure of the cotton crop there, but the staining position improved progressively towards the north-east, Lubaga being in an intermediate zone.

Bollworm.—Bollworm, chiefly American Bollworm, *Heliothis obsoleta*, (*H. armigera*) with Spiny Bollworm, *Earias sp.*, to a lesser extent, did some damage to the cotton crop, but not on a scale comparable with the jassid or stainer damage. The attack was patchy.

One field suffered appreciably in April. A very heavy attack on pigeon-pea in April–May showed that American bollworm is potentially dangerous to cotton on Lubaga.

Other Pests.—The only other cotton pests at all numerous were the dusky stainers, *Oxycarenus sp.* No sign of aphis on cotton was seen all the season.

Mycology.

A leaf-spot, *Alternaria* to microscopic examination, was noted in April, and again in May on late-planted cotton, but was never serious.

On parts of Lubaga, and in several of the native plots seen in the district, plants were stunted in the early stages by what may have been a *Rhizoctonia* fungus discolouring the cortex just below ground level and giving the plants the symptoms of "cold feet." Most plants recovered, and grew normally.

Miscellaneous.

The Kaya School continued to run on the lines sketched in previous Lubaga Reports, and had a successful year. More pupils applied for enrolment than could be taken. Other activities of the farm continued as usual, but the implement agency, for selling ploughs, hoes, etc., to natives was transferred to the local ginnery.

The district as a whole had a good season. Food crops were good, and the cotton yields were at least average. The drive for increased production carried out by Mr. King and his assistants raised cotton production in the district to approximately 5,000 bales of lint, an increase of 20% on last season.

Summary and Conclusions.

At Lubaga, an ideal growing season for cotton was offset by very heavy insect attack, jassid and stainers in particular bringing yields to generally low levels. The jassid attack made easy the discarding of much material hitherto doubtfully assessed as jassid-resistant, and threw into relief the really resistant strains, among which some of the newly-introduced Gatooma strains were outstanding. Much good plant breeding material, from a range of sources, is now available, and the proving of a strain which is a marked improvement on the present district stocks should be chiefly a matter of time.

Cultural experiments indicated the importance of close spacing of cotton under local conditions, and confirm the knowledge of the general benefit of farm-yard manure to grain and cotton crops. The method of cultivation known as tie-ridging again showed favourably.

The district had a successful season, and the cotton crop was up by about 20% on last season.

The conclusions to be drawn from this one year's survey of local problems, are first, that a jassid-resistant cotton is a necessity, and that such a cotton can doubtless be attained through straightforward plant selection. Secondly, that attack by stainers and other cotton pests may be so serious as to be a limiting factor to cotton production; solution of the stainer problem is by no means obvious, and in the meantime the position can best be met by giving the plant the best possible chance by detailed improvements in agricultural practice—knowledge of such improvements in the way of husbandry, spacing and time of planting is rapidly accumulating.

PROGRAMME OF WORK FOR SEASON 1940-41.

Preliminary Note.—The programme of work for 1940–41 has been reduced to limits within which it can be effectively handled under present conditions.

The Kaya School and other activities connected with Lubaga will be run as usual.

The area under cultivation will be reduced to about 120 acres, of which one-third will be cotton. The stock of cattle has already been reduced, and is still ample for maintaining the fertility of the farm.

Cotton will be used as the medium for cultural experiments. Knowledge of the agricultural requirements of cotton seems less advanced than that of other crops. Experimental work with non-cotton crops will be dropped, except insofar as rotation or fertility experiments are concerned.

Soil Fertility.—Mixed farming is taking hold in the district, but rotation of crops is almost non-existent, although presumably a fair part of the benefit of mixed farming would be in rotation. A rotation experiment will be started.

Blocks for observing the ultimate effect on the soil of various crops, resting or otherwise, will be laid down.

Manurial experiments will be carried out on both black and red soils, and composting will be tried.

Cotton Breeding.

Bulking of jassid-resistant strains.

Formal yield trials of these.

Single plant lots: first assessment for jassid resistance and other qualities.

Further selection within any profitable material, making high jassid resistance the criterion.

District observation plots, and trials, if seed is available.

Insect Work.

Large-scale blocks to observe the efficacy of trapping stainers by cotton-seed; seed is plentiful and is available free should trapping eventually prove practicable for the district.

If time permits, insect population records and simple plant development records, for analysis of insect attack and crop development and loss.

District observation plots.

As a district measure, control of loose cotton seed dumped near ginneries and stores.

Cultural Experiments.

Spacing trials; one if possible on typical poor district soil.

Optimum time-of-planting experiment.

Method of cultivation trial.

KINGOLWIRA EXTENSION FARM.
PROGRESS REPORT FOR THE SEASON 1939-40

BY
A. H. McKINSTRY.

Introduction.

Crops and weather background : –At Kingolwira relatively small acreages of a local variety of cowpea, green gram, and maize are planted on the " short rains," from October to February. During this period the narrow, riverine area, because of its richer soil and the greater likelihood of moisture conditions being better, is favoured for cultivation. At the start of the " long rains," in February or March, the main acreages of food crops, principally maize and sorghum, are the first sown ; cotton, the cash crop, is planted soon after the food crops. Finally, beans and further acreages of cowpeas and gram are, in some instances, interplanted in the established maize crops, about the end of April. Effective rains fall, in most seasons, in May and June.

The cycle of planting events outlined for Kingolwira is applicable in the main to other parts of the district ; but important variations of practice occur connected with richer soil and/or a better rainfall distribution than is usual at Kingolwira. Thus in some areas, two crops of maize may be grown with certainty during the course of a season, and in other areas of rich soil, it is better, for the sake of style of growth and fruiting, that the planting of cotton be delayed until about early April. In many instances the areas chosen by natives for cultivation lie near the hills and mountain ranges, situations where soil and moisture are more often favourable to crops than they are in the more exposed situation at Kingolwira.

Meteorology.

The short rains this season were a failure. Only for about a month, from early January to early February, were conditions favourable for planting small acreages of food crops. Planting started on the long rains at the very end of February, and there were favourable opportunities for sowing crops in March. Showery and overcast conditions which prevailed during April induced a sappy type of growth in cotton growing on soil in fair heart, but delayed the development of the plants on new land. No effective rains fell after the end of the first week of May ; thereafter a few light showers, and early-morning ground mists freshened the plants on occasion,

but they added little to the soil-moisture content. The sudden cessation of the rains was general, although in varying degree, throughout the district and, in consequence, cotton yields were curtailed in many areas.

Agriculture.

Fifteen acres of sorghum, about ten of cowpeas, and thirty of maize were planted in early January. Maize has not, in previous seasons, been sown to this extent on the short rains; but it was thought advisable in present circumstances to make every attempt to grow adequate supplies of food for the farm labourers. The main plantings of maize and cotton, 120 and 60 acres respectively, were done during the first two weeks of March; the cotton being planted within a few days, and the maize over the period. Conditions for germination were good, but both the maize and cotton seed from 1939 stocks were badly damaged by insects and, in consequence, germination was poor in many instances. For this reason, the two main cotton strain trials were abandoned. Re-planting with similar seed proved useless. (Sulphuric acid, with which the seed should have been treated, could not be readily obtained this year.) However, as it happened, the cotton crop was destroyed by American bollworm and jassid attack (see Entomology).

After much refilling, on a number of suitable occasions, good stands of maize were finally obtained. Maize yields were very good; about eight bags (200 lb. grain each) per acre were obtained.

Experiments :—Poor stands were the primary cause of abandoning the two main strain trials; and subsequently insect attack on cotton vitiated results from other experiments. Thus, a trial with cotton, and cotton interplanted with (*a*) cowpeas and (*b*) groundnuts, was abandoned; and the yields from the crop rotation and manurial trial were affected, both by insect damage to cotton, and by the uneven growth obtained in the maize plots.

The following results, of an indicatory nature, were, however, obtained from three observation plots in their second year. The plots were situated at some distance from the main cotton lands. The area was described in the 1938 report as being of a certain red soil type, deficient in available phosphorus. Plots were planted with Local cotton :—

Yield: lb. Seed Cotton per Acre.

(1)	Farmyard Manure @ 4 tons per acre	335
(2)	Bone Meal @ 2 cwt. per acre	273
(3)	No Manure	255

In another experiment, where cotton was planted on the same red soil area, digging half the number of plots with a hoe to a depth of about four inches and leaving the other plots undug, gave increases in yields in favour of digging for all of the five years that the series of dug and undug plots have been under cultivation. Differences in yield were of the order of 100 lb. seed cotton per acre in favour of the dug plots under cultivation for two, three, and four years. Differences in favour of digging were, however, very small in those plots which had been under cultivation for either one or five years.

Similar series of plots were planted with maize, groundnuts and millet. Yields were for various reasons unreliable for making comparisons between dug and undug plots. As there is a fair acreage of this red soil in the settlement area, further experiments will be designed to test simple manurial and cultivation practices which might give increased crop yields in the hands of the native cultivator.

Cotton Breeding.

Groups of strains originally imported from Mwanza, Bukalasa, Serere, and Barberton; Kingolwira selections from some of these; a range of selections made from Local cotton; and new strain importations from Gatooma, and Barberton were all sown in duplicate, in observation plots. Owing, however, to the severe damage caused by American bollworm and jassid, yields were very poor. No useful comparisons could be made. Nevertheless, observable differences in strain reactions to bollworm and jassid attack showed up to advantage the Gatooma and, to a lesser extent, Barberton strains, which have been selected and purified under conditions of attacks by these insects. On a first acquaintance with Local strains, 35/553 appears to be the only one possessing a sufficient promise of a reasonable combination of jassid resistance, fruitfulness, and desired standards of lint characters.

Except on a few very small areas jassid damage was universally severe on the Station, but there was little such damage to the Local strain, grown on the peasants' holdings nearby, nor was any marked jassid damage seen on any crops of Local cotton in the few, but widely separated, areas of the district, which were visited. Thus, although the damage done to the Station's cotton might be considered exceptional, yet it may be taken as sufficient evidence that a high degree of resistance is necessary in strains bred up under Station conditions.

In addition to breeding for jassid resistance, much work is also necessary in selecting and purifying different strain types and testing

them on the different soils and under conditions which exist in the district as a whole. Should jassid not prove the danger that it has been at Kingolwira this year, Local appears to offer a wide field for the selection of types suitable for different areas.

Entomology.

Jassid :—Jassid was found in the crop in its young seedling stages of growth ; glabrous plants, of which there are many in Local strain populations, were then " struck." The attack, however, developed tardily, and it was not until the end of June that it became intense. Then, few strains withstood the onslaught ; and this despite the fact that American bollworm had by that time relieved the plants of the effort of making a crop.

American bollworm :—About May 10th, American bollworm larvae were nibbling noticeably at squares and flower buds. The attack developed to epidemic intensity by the third week of May, and by the end of the first week of June there was very little crop left on the plants in the breeding-plots. Both of the main fields were affected similarly, and only a few small areas, most of them situated at a distance from the larger acreages, escaped severe damage. This American bollworm population was probably bred up to a large extent on the 30 acres of maize planted on the farm in January, and to a lesser extent on plantings of maize and other crops made by natives in the riverine area about the same time. This maize tasseled over a protracted period about the end of February and in early March. On the other hand cotton planted about two weeks later in the peasant holdings nearby was not badly damaged by bollworm. It would therefore seem that the Station's cotton, because of its earliness, acted as the ideal trap crop for American bollworm. Thus the attempt as a wartime precaution to produce quantities of maize—the main food crop—has in the circumstances described resulted in severe insect damage to cotton—the main cash crop.

From observations made on crops of other areas it would seem that American bollworm does in certain exceptional instances cause severe damage. Details of such attacks need investigation, but it would appear that the bollworm populations could have bred up on early plantings of maize. In general, however, the wide range of planting dates for maize, cotton, and other crops, coupled with a rich indigenous flora, probably tends to spread bollworm development and activity over a variety of crops and plants. The insect is not therefore likely often to cause severe damage to the cotton crop.

Cotton Stainers :—A small population of stainers consisting mainly of *D. cardinalis* and *D. intermedius* was present in the crop soon after flowering started. The very first of the bolls which split towards the end of June showed symptoms of Internal Boll Disease. It is probable that this damage was caused by a small stainer population, possessed of a high degree of infectivity, feeding on small numbers of young bolls. The meagre crop made it an unsuitable field in which to observe stainer populations. On the peasants' holdings, where yields were fair, staining was not much in evidence.

Other insect pests.—Lygus and Spiney bollworm were also present in the crop during May. The damage caused by these insects was however of minor importance.

Mycology.

A leaf mildew, *Ramularia areola* occurred here and there throughout the crop ; but it caused no apparent loss.

Summary and Conclusions.

Cotton was planted under favourable conditions in March ; overcast showery weather during April induced unbalanced plant development. The rains ended in early May, about two months after most of the crop was planted. This latter factor was primarily responsible for the short yields which were obtained in many areas.

On the Station very heavy attacks by American bollworm and jassid caused almost complete failure of the crop. The fact that this crop was planted about two weeks earlier than that on the neighbouring peasants' holdings, and was comparatively large in area, probably made it an ideal trap-crop for bollworm. It is likely that the bollworm population was bred up on an acreage of early planted maize.

Of the few, but widely separated, crops of the district visited, at least two areas showed evidence of considerable loss from bollworm attack. There, again, bollworm could have bred-up on plantings of maize made early in the season. However, on the whole, bollworm damage was not much in evidence. The variety of crops planted within the span of a season, and the richness of indigenous vegetation in many areas of the district, make it unlikely that American bollworm should concentrate its attacks on cotton.

Jassid attack was severe on most of the Station's crop ; where it was worst only some of the Gatooma strains withstood the attack successfully. Of the Locals 35/553 promises most in the way of selections for jassid resistance in combination with other desirable

plant and lint characters. In the peasants' holdings near the Station, and in those parts of the district visited, the Local strain, a mixture of types many of them susceptible to jassid, was hardly affected by the jassid populations existent on parts of the Station. Previous reports for 1938 and 1939 indicate that jassid can be troublesome on the farm. The position needs further investigation.

Two experiments on a certain red soil type indicate that yields might be increased by applying farmyard manure and by digging the soil to a depth of about four inches. Further experiments will be carried out to investigate these factors.

Other Activities.

Peasants' Holdings :—Peasants have as a group worked satisfactorily throughout the year. They seem to fit in well with, and be appreciative of, the organisation of the settlement, which is being built up for their benefit.

Some concern is being felt for the low state of fertility of the soil on holdings in the poorer soil areas. Many of these have been under cultivation for three or four seasons, and it is obvious that a measure of mixed farming is now imperative. Consideration is therefore being given to the immediate introduction of cattle on these holdings.

Anti-tsetse work :—Dr. J. P. Glasgow of the Tsetse Research Department spent some time on the settlement on two occasions. He found that, because of the effective clearing of bush, many of the older fly-rounds had ceased to yield useful information. He therefore brought into use new rounds which had been marked out further afield. It is hoped that records taken on them will give information which will indicate the more suitable directions in which settlement should expand. Dr. Glasgow has recently been called up for military service, but records of the flies taken on the rounds will be continued by a recorder boy of the Tsetse Research Department.

Much of the riverine area adjacent to the farm has been thinned of all but clean-bolled trees ; and on the farm itself, bush re-growth over a considerable acreage has been cut back. The D7 tractor, and a gang of prisoners from Kingolwira gaol greatly facilitated such work. They are now at work on a barrier-clearing (of 300 yards) of the bush which surrounds the holdings on to which cattle will be introduced.

Livestock : — There have been no deaths due directly to trypanosomiasis, or indirectly to causes connected with the injections given against the parasites.

An outbreak of East Coast Fever, the first to be recorded on the farm, caused a 20 per cent. mortality in the Station's herd. Immediate use was made of the dip-tank which had long ago been built against such a contingency. The Veterinary Department has recently stationed an African Veterinary Assistant at Kingolwira. He will attend to matters connected with the health of livestock on the farm and on the Peasants' holdings.

Model village :—During the year a butcher's shop was opened. Other units of the village, the hospital (dressing-station), general store, and school continue to function satisfactorily. The school children have their plot of land, and they are proud of the fact that they now have cash on hand from the sale of their cotton crop. Having the use of the money, they propose to spend it on new uniforms.

PROGRAMME OF EXPERIMENTS FOR 1941.

A good deal of time is occupied with work connected with the various subjects of which brief mention has been made under " Other Activities "—i.e., day-to-day jobs of first importance to the development of the Settlement as a whole, but details of its future programme, and even much of its progress, would be out of place in a volume dealing with the work of the Experiment Stations.

Work connected with plant-breeding and agricultural experiments, for which plans are being made, is as follows :—

Cotton Breeding.

1. About 150 selections have been made from Local strain types ; many of them from 35/553. A few selections have also been taken from some of the Gatooma and Barberton strains. This material will be under observation.
2. A fair acreage of 35/553 will be planted.
   Objects :—(*a*) to make further selections, and (*b*) possibly a special bulk.
3. Observation plots of a number of strains showing good jassid resistance, and of a lesser number showing poor resistance will be grown.
   Object :—(*a*) to make further observations, and comparisons, and (*b*) selections in the resistant groups.

Trials.

1. Probably trials in which treatments are (*a*) simple hand cultivations, and (*b*) a type of compost will be carried out.

One or more of such trials to be sited on different soil types in the peasants' holdings.

2. Possibly a combined Time-of-Planting and Spacing trial.
3. Possibly a trial in which plots of land are rested under various crops and grasses for varying lengths of time.

NYASALAND

COTTON EXPERIMENT STATIONS, PROGRESS REPORT FOR THE SEASON 1939-40.

BY

H. C. DUCKER, W. L. MILLER AND S. T. HOYLE.

Introduction.

In spite of the upset due to the war, and consequent outside demands on the energies of the staff, it was possible to carry out the programme planned for 1939–40 in considerable detail, but full examination of all results has not yet been possible.

Meteorology.

The total rainfall for the season was just under 34 inches, a little more than average. The distribution was excellent, and there was no period from planting time in the latter half of December to the end of the rains in April when there was either too much or too little rain.

In the Lower River, at the Chiromo Sub-Station, rainfall distribution and amount were likewise good, and planting was possible at the dates planned in the various experiments.

Domira Bay Station.

Agriculture.

Cotton.—The good rainfall distribution, combined with but slight insect attack, as a result of the plant sanitation measures carried out in the previous three years, allowed the crop to grow steadily without a check. The cotton crop was the largest so far recorded by the Station.

The mean yield was approximately 350 lb. lint per acre, actually 973 lb. seed-cotton per acre, of which some 95% was clean and white. One five-acre field, which has been under cultivation for eleven years, including two rest periods, and has had no manuring, was planted with a bulk of Z.14 and gave the high yield of 470 lb. lint per acre.

A small bulk strain trial, following the method of J. B. Hutchinson, with ten sub-strains each of "920," C.28, and some of the crosses was planted. As was general on the Station, yields were high, ranging from 310 to 530 lb. lint per acre.

It was again confirmed that the U.4×Cambodia×U.4 cross is the highest yielder, Harland's version of this cross being the best, with a locally-made cross second. There was no significant difference in yield between the U.4 derivative " 920 " and C.28 and the other crosses in this trial.

A standard strain trial was planted with five recent introductions of U.4 origin from S. Rhodesia, two from Barberton, two locally selected strains of U.4, and the Nyasaland Upland strain S.G.27. The latter is locally acclimatised, having been re-selected for jassid tolerance at Domira Bay over a period of eight years. There were no significant differences in yield between seven of the nine U.4 lots, but the S.G.27, which closely resembles the old Nyasaland Upland formerly grown by the A. L. Bruce Estates, yielded less seed-cotton and, owing to its low ginning percentage, much less lint than any of the U.4 strains.

An experiment was planted which was designed to discover if acid treatment of seed increased the yield, and if different strains would give different responses to such treatment. Four strains were used, two U.4 lots and two crosses.

The final result was that the acid-treated seed gave about 8% more than the untreated seed and that there was no differential response among the strains.

In order to study the effects of seed rate and time of thinning these two factors were combined in one experiment. There were no significant differences in final yield. The lowest seed rate used, five seeds per hole, had many more blanks than the other seed rates, but not enough to affect the final result. This might not have been the case in a less favourable season.

Cultivation experiments were continued, this year in fields planted to groundnuts and cotton respectively.

The experiment with cotton again showed that the most important effect was an increase of yield in the ridged plots compared with those planted on the flat. The dug plots were just better than the plots with no pre-cultivation.

No cotton plots occurred in this year's breaks of the rotation experiment, the whole area of which is due to be planted to cotton in 1941–42.

Rotation Crops.—The cultivation experiment in which this year groundnuts were planted demonstrated that there was no difference between ridge and flat, but that the dug plots were better than those dug only in strips along the planting rows, while the latter were better than those which had no pre-cultivation at all. The dug plots gave an increase of nearly 10% in yield over the undug plots, an advantage

for digging which had not been demonstrated with cotton. Future experiments will show if this is peculiar to the groundnut crop or whether no digging has a cumulative adverse effect.

In the rotation experiment two points of interest appeared this year. The first was that groundnuts planted two years after a previous crop of groundnuts gave approximately 50% of the yield of plots which had not carried groundnuts previously in this experiment. The second was that maize planted after a groundnut crop gave a 38% increase in yield over maize planted after cotton, all plots having first had two years under cotton.

Maize.—Planting conditions in early December did not suit maize though they improved later. Germination being slow and patchy, the loss of seed due to the depredations of guinea fowl and baboons became serious in some fields. Once the crop got away, however, growth was good and yields proved satisfactory, the final figures for three fields exceeding 3,000 lb. per acre.

Only one experiment was attempted, a repetition of the 1939 spacing experiment, but stands proved so irregular that it was abandoned. The present standard spacing of three feet by three feet, using three seeds per hole, appears satisfactory. The seed used on the Station is now entirely that derived from the selected bulk of native maize mentioned in previous reports.

Groundnuts.—Gambia Bunch was the only variety used in the main rotation. It gave the excellent yield of 40,000 lb. from 25 acres.

In an experiment to discover whether any advance had been made by selections within this strain, no significant differences in yield were found between seven sub-strains and bulk.

A combined time-of-planting and seed experiment was carried out, using shelled and unshelled seed. Planting conditions were very good for the second date used, December 29th, and an increase was shown over the first date, December 19th, but the third and fourth series, sown on January 8th and January 18th respectively, were significantly worse than the first two. The two last plantings suffered severely from " Rosette " disease. Planting unshelled seed reduced the stand and so the yield, and its disadvantages are probably explained by the simple fact that seed in a pod cannot be examined for soundness. An increase in the seed rate would probably reduce the difference in favour of the unshelled seed, but might not appeal to the native grower.

Bambarra Groundnuts.—A combined time-of-planting and spacing experiment confirmed last year's results. Early planting is essential and ridge planting shows a slight advantage over flat.

Pigeon Peas.—Much of this crop, which is at present in use as a cover during the rest period of breaks 5 and 6 in the main rotation, died out during the 1939 dry season. It was not possible to elucidate the reason, but correspondence revealed that " pigeon pea sickness " is well known in other parts of the world. Plans were made to obtain material for mycological examination in 1940, but fortunately or unfortunately according to the point of view, the new plantings this year are well-grown and healthy. It therefore seems possible that the dying out in 1939 was a seasonal matter which might have been linked with the early close of the rains in that year and the intense dry season which followed.

Elephant Grass.—This is being used as an alternative cover crop to pigeon peas in the rotation experiment, and is giving very good results to date. In view of the doubt which now obtains regarding the future of the pigeon pea crop at this Station, an experiment was laid down to ascertain the best time and method of planting elephant grass. As far as it has gone at present it would appear that the grass may be planted under a maize cover in precisely the same way as pigeon peas, and that quite a wide spacing may be satisfactory.

Miscellaneous crops.—Green gram, Bulrush millet, sorghum, simsim, and soya beans were grown in fields outside the main rotation, and the collection of groundnut varieties was maintained in small bulk. As in 1938, the simsim gave a very good yield, and the success of this crop would appear to depend on satisfactory rain falling in the second half of March.

Genetics and Breeding.

This year the work was mainly confined to the continued sorting out of U.4 stocks and some of the crosses which have been longest in cultivation. Hair character tests which have been made by the Shirley Institute have shown that the only U.4 material giving lint with a quality sufficiently good to meet the demands of the commercial buyers is in the original bulk now in commercial use, in the " 920 " strain, and possibly in C.28. Accordingly no more work will be done on the other U.4 strains though some of them will be retained in small bulk for possible use as parents in future crossing.

The " 920 " bulk gave a very good yield per acre, and arrangements have been made with an estate under the control of the African Export Corporation to increase this stock for commercial trial.

The highest yielding cotton on the Station, Harland's U.4× Cambodia× U.4 cross, gives, on the whole, very coarse lint of poor quality, but certain of the selections now in small bulk have lint of very

much better quality and still retain the high yielding power of their parent.

Another cross from Dr. Harland, U.4 × Gambia × U.4 produces a very large number of small bolls, a character which may be of value in combating certain pests. Its yielding power is good, and certain re-selections show a much improved lint quality.

The local cross, S.G.27 × Over the Top B.30.1 has probably the best quality lint of any cotton on the Station, and this year its yield was good. The plant has long internodes and makes its crop from a small number of large bolls, and it is possible that in a less favourable year it would have been outyielded by smaller bolled types of more prolific habit.

Samples of the best of the selections from the above mentioned strains and crosses have been sent to England for spinning tests.

New Introductions.—These included S.P.84 and N.17 from Uganda, and "561" from Tanganyika. S.P.84 is a derivative from U.4/4/2, but the habit of the plant as grown in Nyasaland is unlike that of U.4. types and resembles the habit of Nyasaland Upland. It was grown on a fertile patch of soil and gave the high yield of 1,300 lb. of seed-cotton per acre. The lint quality appeared to be well above the average of U.4 stocks.

The other two strains both grew well and should provide some most interesting material for selections, especially the "561."

Three small lots were obtained from Russia. Two were fairly resistant to jassid but their lint was short and coarse.

Single-Plant Selections.—Last season, samples from a wide range of native-grown gardens were collected and their lint submitted to brokers' tests. The results suggested that in the commercial bulk was to be found a range of material of considerable value. Accordingly, 178 single-plant selections were made in small bulks grown from the seed of seventeen market areas, which will be planted in progeny rows in 1940–41. Special emphasis was laid on lint quality in making these selections.

Crop Development.—The system of tagging flowers and recording their subsequent fate was continued and extended in co-operation with the Insect Pest Control Section. The extension consisted mainly in a more accurate grading of bolls damaged by pests or disease.

A randomised block experiment comparing one and three plants per hole was used and each of these treatments was sub-divided into three sub-plots in which (1) no recording was done ; (2) bollworm eggs and larvæ were counted, a sample of flowers tagged once weekly, and dead and ripe bolls collected twice weekly ; and (3) bollworm eggs and larvæ

were counted and observers made " Plant Diagram " records on sample plants.

There was no significant difference in yield between one and three plants or between the three sub-treatments. This shows that in a good season, at all events, the handling and trampling effects had no influence on final yields.

In the first part of the season there were significantly more flowers in the three-plant than in the one-plant plots, but the tagging records show that a higher percentage of the flowers from the one-plant plots made crop than of the flowers of the three plants per hole plots. Later in the season there was no difference in flowering rate between these two treatments.

The tagging records confirmed the 1939 finding that on the Station the bulk of the crop set comes from flowers opening during a very short period. Seventy per cent. of the final crop was made from flowers set in the three weeks from March 18th to April 8th, and ninety per cent. in the five weeks from March 11th to April 15th.

In the 1939 season, when the flowering was cut short by cessation of rainfall in mid-March, ninety per cent. of the crop was made in the five weeks from March 1st to April 5th.

Chiromo Sub-Station.

A " staggered " time-of-planting experiment, referred to in the Programme given at the end of the 1938–39 Report, was carried out as planned, part of the experiment being laid out on a piece of land one mile away from the sub-station lands, which was loaned to the Corporation by the British Central Africa Company.

This part was used for the first three dates of planting, December 18th, January 1st, and January 15th.

On the Station the dates used were January 15th, February 1st, February 15th, March 2nd, and March 15th.

The working out of all records made on this Experiment cannot be completed in time for this report, but preliminary observations show that the highest yields came from January 15th, February 1st, and February 15th plantings, the middle date giving the highest yield of these three leaders. Commercial bulk U.4 was used.

A strain trial cum time-of-planting experiment, using " 920," U.4 Commercial bulk seed, and the Nyasaland Upland type S.G.27, with plantings on January 25th and February 20th, provided results of interest. The commercial bulk U.4 and " 920 " were both higher yielding than the Nyasaland Upland, but the difference in yield between the two U.4 lots was not significant.

The yields of the commercial U.4 in this experiment fit neatly into the range of yields shown by the main time-of-planting experiment on the sub-station, and a summary of the total returns for each date, in kilograms, is given hereunder.

January 15th.	70·06	February 15th.	82·26
January 25th.	86·78	February 20th.	66·68
February 1st.	83·06	March 2nd.	35·18
		March 14th.	23·44

A plant arrangement experiment in which cotton and maize, and cotton and groundnuts, were inter-cropped in various ways, showed decisively that cotton and groundnuts could not be satisfactorily combined under this season's conditions at Chiromo, and suggested that the higher the percentage of maize on the land, the lower the yield of the cotton, even though the latter made its crop long after the maize had ripened and been removed.

It must be recorded with regret that the plot returns from the 1938–39 crop were so affected by insect pest attack that no reliance can be placed on the figures. The "staggered" time-of-planting experiment carried out this season was an attempt to evade the effects of pest "bombardment" from earlier plantings on those made later, and the tagging and pest records conducted by the Insect Pest Control Section should, when completely worked out, indicate how far this proved successful.

Summary and Conclusions.

A very favourable season set a new high level for yield standards, and the effectiveness of the close season measures adopted during the past three years for the control of the major pests has been confirmed in the summer crop areas represented by Domira Bay.

A superior strain of U.4 has been bulked and its distribution for commercial trial commenced, and the assistance given by the Shirley Institute is paving the way for a further advance in solving the vexed problem of "quality," and its reconciliation with high yielding power.

The work on general agricultural problems continues to progress, and several important facts have been revealed by the work done this year.

The results obtained at Chiromo have yet to provide a definite answer to the much disputed problem of time-of-planting in the Lower River areas, but so far as they have gone they suggest that planting just before the middle of the main rains, and confining the range of planting dates to a quite limited period may be the answer to our pest problems in that area.

PROGRAMME OF EXPERIMENTS 1940-41.

It is impossible to give a detailed programme since there is much uncertainty regarding the staff which war-time demands will leave to carry out the work, but an attempt will be made to continue all long-term experiments, to maintain the breeding material in small bulk and to grow increase plots of all the more promising strains and crosses ; to continue strain trials at Domira Bay, and to continue the time-of-planting cum variety experiments at Chiromo.

ENTOMOLOGICAL WORK.

PROGRESS REPORT

BY

E. O. PEARSON AND B. L. MITCHELL.

The outbreak of war, and the arrival of the first-named writer from Barberton in November, 1939, considerably altered the scope and emphasis of the programme originally published for this season.

The original intention as regards stainer work was to develop, by the survey methods already used in South Africa, the study of the bionomics of stainer in the Lake Shore area, with the expectation that eventually much of the fundamental work on internal boll disease and its chief vectors would be carried out in this region, against the background provided by such preliminary studies. Of recent years, however, the problems raised by insect pest damage to the Lower River crop have become extremely urgent and this fact, coupled with the incentive provided by the war to emphasise work on more immediate problems whose early solution might be of value to the war effort, led to a drastic change in our research policy.

It was decided that, first, the immediate requirement was for definite and comprehensive information as to the nature and extent of the crop loss due to pests and diseases in the Lower River and the measurement of all factors affecting this loss, in the hope that it might be possible to ameliorate these conditions, once they had been defined, by using such knowledge of the bollworm and internal boll disease problems as we already possess. Secondly, it was decided that where

any conflict for time and energies arose between this survey work on the Lower River and that of a more general and long-range research character, the former would have precedence.

The receipt of the Scientific Committee's preliminary memorandum on research policy, with its suggestion of centralisation of research at some point in Africa, probably to our north, together with the fact that long-range research at the Barberton Station had been suspended consequent on the release of many of our colleagues for war service, confirmed our view that it was a sound move to shelve any development in the direction of long-range research and to concentrate all our efforts on a limited and perhaps rapidly realisable objective.

A programme which very greatly expanded the one previously published was made out in December, 1939, giving effect to the revised lines of policy outlined above.

The Lake Shore Area.

Insect Population Records.—Routine records on bollworm and stainer populations were obtained from a number of fields on the Domira Bay Station and also from native gardens in the main vegetational types of the Lake Shore area. The initial bollworm infestation, derived from moths emerging from pupæ which had been in diapause since the previous season, was remarkably light, and a very good crop was set before the first generation bred in the crop began to make its appearance at the end of March.

The stainer infestation started with a small immigration during March, amounting to a few hundreds per acre and unaccompanied by breeding, almost entirely composed of *D. intermedius*, followed by a secondary and much larger immigration which coincided with the start of boll-opening in late April. Fifth instar nymphs appeared 2–3 weeks later and by June a massive population had been built up (17,000 *D. intermedius* 5th instar per acre), of which, however, only a fraction of the derived adults remained in the field, the remainder dispersing very soon after reaching the final moult. The peak population of adults was thus only 3,000 per acre. This is apparently a specific character of *D. intermedius*, as similar behaviour has always been observed in South Africa. From mid-June onwards this species almost completely dispersed from the field.

D. fasciatus, though on a much smaller scale, also came in during late April and built up a considerable population in June, but differed markedly from *D. intermedius* in that the adults remained in the field without dispersing as soon as they matured, the population in mid-July, when records ceased, being the peak for the season (4,000

adults and 12,000 5th instar per acre). This confirms a specific character also noted in the South.

For the second year in succession native gardens in the district carried a considerably heavier bollworm population than the Station. The reverse was the case with stainers. Qualitatively, the course of events was similar in all the Lake Shore area recording sites.

Plant Development and Crop Loss.—In a composite experiment to elucidate the factors causing crop loss, especially in relation to the local practice of leaving three plants per hill, and simultaneously to examine the merits of different techniques for such studies, an experiment was carried out in collaboration with the Plant Breeding Section, the details of which have been given in the first section of this report.

In addition to the fact, reported above, that there was no significant diminution of yield in plots where the various recording methods had been carried out, it was also found that there were no significant differences in yields or skeletal weights* between plants used for plant diagrams (in which the history of every fruiting point on the plant is followed by twice-weekly examinations) and adjacent control plants. There is thus no significant handling effect either on the fruiting points themselves or on the vegetative scaffolding supporting them. Either the bulk tagging method or plant diagrams may thus be used with confidence.

The plant diagram method has the advantage that a complete record, without any loss of information (such as occurs in the other method due to loss of tags) is kept of all fruiting bodies, including buds, and that the behaviour of different zones of the plant may be separately studied. Its main drawback is the enormous amount of office work required to get the results into a manageable form.

Full discussion of the results of the crop development studies must be deferred, but the following points may be mentioned.

Fifty-seven per cent. of the crop was derived from buds produced in the last fortnight of February; 95% from the 6 weeks ending the 23rd March. The first 43% of the buds formed produced 90% of the crop. Of the four main types of crop loss, that of shedding due to unknown causes easily ranked highest in point of numbers, but it seems probable that this merely represents an effort on the part of the plant to maintain its liabilities at a level at which it can efficiently discharge them. 66% of the fruiting points are lost by shedding of this type.

Bollworm accounts for 19% of the total number of fruiting points, but the loss is largely made up of buds and bolls shed and as this

* Air dry weight of plant skeleton after harvesting—stripped of all leaves and bolls, only the branch and root system remaining.

shedding may be selective, it is possible that it does not represent a true loss of crop. This will only occur where bolls are damaged which are irreplaceable and which represent a genuine investment on the part of the plant. Shedding of bolls occurs at, on the average, 10 days of age. At this age they are from 7 to 10% of the dry weight of mature bolls and thus only represent to this extent an irreplaceable loss.

Apparently we should look to that portion of the non-shedding boll population which is damaged in order to obtain a true conception of the sources of crop loss—at any rate under the conditions experienced this season. These are illuminating. Bollworm only accounted for a loss of 10%. Bacterial disease (direct attack) and immaturity, the latter probably associated with one of the other main sources of loss, each accounted for 3½%. Stainer accounted for 38% and was thus easily the largest source of loss. Nearly half the bolls which set gave rise to clean cotton.

Practically the whole of this stainer damage seems to have been done by the immigrant population, and it is a surprisingly high figure considering the not unduly large immigrant population. The F_1 population of 5th instars, although large, did not appear until mid-May, by which time over 80% of the bolls which ultimately contributed to the crop were over 6 weeks old—the critical stage after which stainer attack becomes relatively ineffective.

There is no significant difference in yield between the 1 and the 3 plants per hill, although the latter produces about 13% more flowers. The levelling-up in the yield comes mainly from the greater loss due to stainer in the 3 plants per hill—nearly 25% more. This happens to be the same figure as the excess stainer population in the 3 plants per hill plots over the period in which the excess loss is incurred—an excess probably due to the attractiveness of the 3 plants per hill in virtue of their greater cover and larger boll population at that time.

As might be expected, there is a vast difference between the zones in which the two treatments produce their crop : in the single plants half the total bud production comes from the monopodial zone, whereas in the 3 plants per hill this zone is greatly suppressed, 75% of the total buds coming from the first 10 sympodia. It is noteworthy that both treatments reach approximately the same peak load of bolls and that up to the time of reaching this the 3 plants per hill are shedding more than the one plant per hill, presumably to counteract their heavier flower production. In bad early bollworm years, some benefit would be derived from this reserve balance.

Red Bollworm Diapause.—The central problem of the bollworm

situation in this country is the pupal diapause, as it is upon this that the whole question of control ultimately hinges.

Emergence of pupæ in 1939–40 confirmed the findings outlined in last year's report, namely, that whereas pupation occurring in February, March and April is mainly short-term, moths emerging from 3–5 weeks later, from May onwards a large proportion of the pupæ go into diapause and do not emerge as moths until the following December to March, or, in the Lower River area, as late as May.

A moth flight curve has been constructed for the Experiment Station from the field populations of fully-fed larvæ integrated with the emergence records of 50 such larvæ withdrawn weekly and allowed to pupate in protected cages. This curve shows the same qualitative features as the independent records of moth activity supplied by egg counts in the field. Emergence of moths from the station cages showed an almost complete cessation from the end of September until the break of the rains in December, 1939; from then until late March, 1940, emergence continued with peaks in early January and late February. Of this seasonal carry-over of pupæ, 31% emerged before the cotton crop was carrying food for larvæ. The remainder formed the initial population infesting the new crop.

In South Africa, on the other hand, emergence of pupæ is complete by the end of December. In order to determine whether this difference is due to pre-conditioning in the larval stage, or to direct environmental stresses on the pupæ themselves, an interchange of pupæ was made with Barberton in the dry season of 1939. The Nyasaland pupæ sent to South Africa behaved in the same way as the local Barberton pupæ, whilst Barberton pupæ sent to Nyasaland behaved as local Nyasaland pupæ.

This interchange was repeated this year: pupæ formed at Barberton in May were buried in pupal cages here, half at $1\frac{1}{2}''$ and half at $3''$, at the end of July. Of these, 30% emerged up to mid-September, when emergence ceased; the remainder are believed to be in diapause. Of those emerging, two-thirds came from the lower depth.

There is clearly some factor present in Nyasaland and absent from South Africa which suppresses the metabolism of the normally developing pupa and forces it into diapause. The most obvious factor is the climatic one: from September onwards temperatures rise and humidities fall steeply, but it remains to be proved which of these factors is the dominant one. This point is being intensively explored. Continuous measurements of soil temperatures and soil moisture contents are being made and the latter are being linked up with soil space humidities by various laboratory methods. An experiment is in progress on the effect of controlled humidities on the pupal period.

The question of the precise depth of pupation assumes great importance, since maximum temperatures and hence saturation deficiencies decline steeply with increasing depth. A more exact knowledge of the distribution of pupæ in the ground has been obtained by sinking 4 bottomless metal drums, without disturbing the earth within the drum, in each of five different cotton soils in the Lake Shore area. Large numbers of full-fed larvæ were collected weekly and placed in the drums, one of which, at each site, was used for each month from March to June inclusive. Conditions were thus covered from the wettest part of the year to the middle of winter.

The pupæ were excavated in late August, at a time approaching the cessation of emergence, so that the living pupæ remaining represented very closely the diapausing element. There was a significant increase in pupation depth from month to month : in all soils in March, over 80% of the pupæ were in the surface inch of soil and only in one soil, a well-worked loam, were they found at a depth exceeding 2″. In subsequent months never more than 70% occurred in the surface inch and the mean depth went down to 2·5 inches in one soil in June. In the latter month two of the clay soils, which crack freely, contained pupæ down to 6″. In no case had larvæ entered clods of soil, the cells without exception being loose in the soil or attached to the exterior of a clod. There was no significant difference between the mean depths of pupæ which had emerged by August and of those which had not.

In order to obtain direct confirmation regarding the distribution and density of pupæ in the soil, a direct sampling of several fields on the Cotton Station has been made in the late dry season (September to November inclusive). The total number of cells found per acre (computed from 20 units of 1 sq. yd. each per acre) agrees very closely with the number expected from the summation of the 5th instar larval population over the same fields during the past growing season. A population of something like 2,000 living pupæ per acre is found to exist at this time of year, now four months since the cotton was cut out ; these pupæ after excavation are imbedded in pupal trays and up to the time of writing (late November) very few of these have emerged, suggesting that the pupal population that they represent is the diapause fraction. The great majority of these pupæ excavated occur in the top, loose layer of soil, roughly $2\frac{1}{2}$″ in depth. Thus a direct confirmation of the evidence from pupal cages has been obtained.

The Lower River.

Of recent years the Lower River cotton crop has suffered a serious decline in production, the causes of which have been variously assigned

to the impact of insect pests, to diseases, to loss of land through flooding and to loss of fertility in non-flood land, to weather, seed deterioration, population movements and the proximity of foreign territory. Different observers have tended to stress the importance of different causes, not always impartially. Clearly our first task was to survey the causes of crop loss as it actually occurs in the native-grown commercial crop.

Native recorders have been trained and established at four points in the Lower River, from which six distinct types of land, representing the greater part of the cotton-growing area, have been sampled. In every region a number of native gardens have been selected and in these records have been made of red bollworm egg-laying and larval populations, stainer populations, flower and boll production, and a weekly sample of mature bolls withdrawn on which determinations of crop loss due to different causes has been made. Altogether 35 native gardens have been studied.

In order to obtain a more detailed dissection of the interaction of plant growth with insect populations and subsequent crop loss, very extensive tagging experiments were carried out on the Chiromo sub-station, covering the whole range of possible planting dates on dry land in the Lower River. Mention has already been made of the methods adopted to minimise insect interference from planting to planting; only partial success was obtained, but the detailed analysis of all the factors concerned has enabled one to assess and thus to discount the effect of such interference. This was accomplished by complete records of insect populations and by the detailed examination of the fate of flowers tagged at fortnightly intervals throughout the season. Bolls developing from such flowers were examined at maturity and the damage due to bollworm, stainer, bacterial disease and unknown causes identified and graded. Upwards of 90,000 such individual case histories were recorded.

In addition, at all four points records of maximum and minimum temperatures, rainfall, evaporation from Livingstone atmometers, dew deposition and wet and dry bulb psychrometer readings at dawn and 2.0 p.m. are made concurrently at a standard station and within the crop. In addition, soil temperatures at pupation depth are read twice daily, at dawn and at 2.0 p.m., using incubator thermometers.

Pupation cages have already been in use at the Chiromo sub-station, on heavy non-flood land, and at Port Herald, on sub-irrigated sandy alluvium, for two years; in the latter part of the present season the use of cages has been extended to the light, dry, sandy land of the Port Herald area and to the rich friable loams of Chikwawa, in the

extreme north of the Lower River. A distance temperature recorder has been installed at the Chiromo cages, with bulbs inserted at 1½″ and 3″ depth.

From all these sample areas a mass of detailed records is available which make possible a comprehensive analysis of the causes of loss to the commercial crop. At the time of writing there is still much work to be done on these records and the conclusions which follow may need modifying when this is complete.

The general situation on the Lower River this season was that the number of growers was 35% more than in the previous year and the final production not quite double; the yield per garden was thus up by one-third, from 174 to 232 lb. of seed cotton per garden. As the average garden is considerably more than one acre, this yield is still very poor. Of the total crop, 72% was number 1 grade; this is the same figure as for the previous year. The whole of this production was from dry land and practically all of it was interplanted with maize or millet; this year the river has maintained a higher average level than ever before and there was no flood land cotton.

Analysis of the causes of crop loss in the sample gardens examined shows that of the total number of bolls which survive to a size where they were susceptible of examination, 46% were a complete loss due to bollworm, 28% due to stainer and 2% due to other causes, including direct bacterial lesions.* Only 24% contributed to the crop. In addition, analysis of aborted material (*i.e.*, bolls which shed or which are attacked so early in life that they never develop), showed that 76% of this loss was due to bollworm. The corresponding figure for the Lake Shore crop was 20·5%.

Records of red bollworm egg-laying and larval populations show that the bollworm year fell into four distinct phases. In the first, occupying March and part of April, egg-laying was at a high level due to the activity of moths from the diapause fraction of the previous season's pupæ, augmented by the earliest portion of the F_1 moths derived from early-planted gardens. During late April, the whole of May and the first three weeks of June, egg-laying was exceedingly heavy, being entirely due to F_1 moths bred in the crop. In the third phase, which extended from late June to the end of August or early September, there was a sharp decline of egg-laying, due to the cooler weather lengthening developmental periods and thus reducing the cumulative

* In view of the suggestion, commented on in last year's report, that *B. malvacearum* was responsible for much of the staining in 1939, the freedom of this season's crop from both Angular Leaf Spot and from direct bacterial lesions on the boll is interesting. Microscopical examinations of stained material this year confirm *Nematospora gossypii* and not *B. malvacearum* as being the causative agent.

moth population. Finally, in such gardens as were still in an attractive condition, there was a fourth phase in September and October of recrudescent activity, due to the emergence of over-wintering, but non-diapausing pupæ.

The effect of the first phase of bollworm activity is to cause a heavy loss of squares and young bolls in the first period of the plant's fruiting activity ; in cases where a high proportion of early-planted (*i.e.*, early January) cotton exists amongst later plantings, this phase may be marked by a complete suppression of flowering in the latter. Where plant growth is very vigorous, however, due to early planting or to poor food crops giving the effect of pure stand cotton, the plant may succeed in outstripping bollworm attack by sheer weight of numbers of fruiting points, so that a small pre-cool season crop may be matured, opening in late May–June.

The second phase of bollworm activity gives rise to an enormous larval population in May and June, which makes itself felt as a severe loss of partly-grown bolls. This damage actually becomes most noticeable, to the casual glance, during July and early August, when these damaged bolls are attempting to open, and is popularly, but erroneously, attributed to the cool, moist weather conditions which frequently occur in July.

The decrease in bollworm activity from late June onwards permits the establishment of a crop from the June–July flowering. The extent of this flowering depends upon the interaction between time-of-planting and competition from the interplanted food crop. Early-planted (January) crops, or medium-planted (February) ones which have not been effectively retarded by well-grown food crops tend to produce a strongly bi-modal flowering curve with a first peak in April–May, and a second in August–September. Their mid-season flowering is sparse and they are unable to take advantage of the lull in bollworm activity at that time. Medium- to late-planted crops, adequately repressed by maize, produce a uni-modal flowering curve, broadly covering May–July, not subjected to a crippling bollworm attack, and opening a crop mainly in August–September.

The fourth phase of bollworm activity, in September–October, is of little importance from the point of view of crop loss, as the bulk of the flowering in these months is in any case shed for physiological reasons.

Stainer activity in all the sample areas followed much the same course, being characterised as follows :—

(i) An initial immigration of adult *D. intermedius* starting in May and extending into June, with a peak population in late May, reaching 1,000 to 2,000 per acre.

(ii) Breeding resulting from this immigration was very restricted; only in one area (Kalonga) did the population of 5th instar nymphs bred *in situ* reach the size of the original peak population of immigrant adults. The adult F_1 was even smaller, due to dispersal from the field as it matured (*cf.* Lake Shore area), and the population declined generally for the rest of the season.

(iii) *D. fasciatus* only occurred in very small numbers except in one area (Kalonga) where a small initial immigration in May succeeded in building up an F_1 population exceeding 1,000 per acre in mid-July. There is a suggestion at most points of a transient immigration of adults in late August.

The bulk of the Lower River crop this season was planted in late January–early February, and it appears that under the conditions in which the native crop is grown and with the heavy April–May bollworm attack, there is a definite shortage of recently-split bolls in May. The development of young nymphs, which cannot take place successfully except on open bolls, is thus restricted in this month. By the time that open bolls are available in any quantity the temperature has dropped to such an extent that breeding, if not actually prohibited, is greatly reduced. This temperature restriction holds during June and July. By the time that the August crop is opening the stainer population has been so reduced in the field that it does not succeed in re-building itself, especially under the conditions of rising heat and dryness in the senescent crop at that time of year.

It is of the utmost importance to clarify the conditions under which this inhibition of stainer activity in the cool season occurs. These become clearer from a study of the time-of-planting experiment, analysed by taggings, at the Chiromo sub-station.

Here the field of earliest plantings (18 Dec., '39, 1 Jan., '40, and 15 Jan., '40) received a main immigration of *D. intermedius* in late April–early May, which, as bolls started opening at the same time, was able to breed immediately. A very large F_1 of 5th instar nymphs developed by mid-June, a part of the adults from which remained in the field, but the bulk of which dispersed.

On the medium-planted field (15 Jan., '40, 1 Feb., '40 and 15 Feb., '40) there was an initial immigration in May, presumably a portion of the same immigration as took place to the crop generally at this time, followed by an additional and much larger immigration clearly derived from the maturation of the F_1 on the earliest-planted fields half-a-mile away. This secondary immigration coincided with the commencement of boll-opening. *From neither of these immigrations was any F_1 developed until August, and the peak of the F_1 generation was considerably lower than that of the original infestation of adults.*

Clearly some factor other than available food supply is operating to restrict the initiation of breeding in June–July, and it seems probable that this factor is temperature.

The state of affairs in the medium planting applies to much of the commercial crop, in which for a variety of reasons no open fruit is available for breeding until the cool season, when climatic factors inhibit it. It is possible, moreover, that some of the later portion of the immigration is due not to direct movement from wild host sources but to pre-breeding on such early plantings as exist.

The effect of these stainer populations on the crop are much greater than would be expected, having regard to their comparatively small size. This may be partly due to under-estimation of the populations: it was not possible to supervise the collections to any great extent and a proportion of the population is certain to have escaped capture.* The results, however, are consistent from station to station, and personal observations did not confirm the fear that the records seriously under-estimated the population. A more probable contributory factor is that this stainer population, though not heavy in comparison with those experienced elsewhere, impinges on a crop which, already decimated by bollworm, is anyway very small.

The general trend of stainer damage is as follows. Any very early crop which escapes bollworm damage also evades much of the initial stainer attack and opens clean. The later part of the early crop, *i.e.*, that opening in June and July, is already badly damaged by bollworm and superimposed on this is severe stainer damage due to the initial migration. This damage is intensified by the fact that the bolls are still at a susceptible age when attacked.

Similarly, where later plantings (February) are producing a crop opening in August, this suffers, though less seriously, from the correspondingly later immigration which comes in June.

Finally, the late crop, coming from the second flowering of early plantings or from the latter part of the main flowering of medium–late plantings, and opening in September–early October, is *relatively* least damaged of all, as it passes through its most susceptible stage at a time when stainer populations are at a minimum.

The actual *volume* of damage recorded is considerably greater in the late crop than earlier in the season, although less in proportion to the total crop then harvested. That is to say, a smaller number of stainers

* The Lower River cotton area is 90 miles long and is situated 300 miles by road from our headquarters.

appear to be doing a great deal more damage later in the season. This is partly an artifact due to the method of computing the damage : early in the season the bulk of the crop is in any case being lost to bollworm ; stainers are also feeding on these bolls, but the damage that they do is obscured by that due to bollworm. If this is allowed for by applying to the total boll production the figure for percentage stainer loss derived from the examination of bolls escaping bollworm, the discrepancy noted above becomes much smaller. It still remains, however, and suggests that some other factor is at work, such as a greater degree of infectivity amongst the stainer population later in the season.

On the time-of-planting experiment at Chiromo the stainer damage was more severe than in the native crops studied. This is in keeping with the much bigger stainer populations recorded here, a difference due partly to better conditions, but largely to the persistence throughout the season of a high level of stainer infestation initiated by breeding on the earliest plantings.

To sum up : the following conclusions may be drawn from this season's observations and experiments. The critical factors determining the amount of *bollworm* damage are :—

1. The size of the moth flight from diapausing pupæ.

2. The amount of breeding-up in very early plantings which may reinforce the latter part of the diapause flight to later plantings.

3. The extent to which moth activity from June onwards is reduced, initially by the lengthening pupal period in the cool weather and subsequently by the increasing proportion of pupæ going into diapause.

The same type of factors control the size of the *stainer* infestation :

1. The size of the initial immigration to the crop in May.

2. The extent to which these immigrants are capable of building up an F_1 on early-fruiting plants.

3. The extent to which cool season breeding is inhibited.

If, as seems probable, the insect activity from June onwards is actually controlled by climatic conditions, then evidently great benefit would be derived by manipulating plant growth so that the main fruiting comes after this critical date. Further, there are substantial grounds for believing that were the whole of the commercial crop restricted in its planting dates, the dimensions of the pest population built up in the crop would be greatly reduced. Finally, there is the possibility of actively reducing the initial infestation of both pests. This involves the consideration of factors inducing and breaking up the

pupal diapause in red bollworm and its susceptibility in this stage: studies on these points are at present being developed.

In the case of the initial stainer infestation, the wild host cycle is involved; here the possibility may cautiously be indicated that there is a weak link in the chain of hosts immediately connecting with cotton. The possibility will be explored in the coming season.

A report on the pest situation on the Lower River would not be complete without reference to the discovery of the existence and subsequent spread of pink bollworm in the area this season. The pest only became conspicuous towards the close of the season and it is not believed to have accounted for any great volume of damage. The preliminary reconnaissance is being carried out by the Government Entomologist, but it is possible that our organisation will be required to add this further pest to its survey programme next season.

Summary and Conclusions.

1. Emphasis is being laid on intensive investigation of the insect pests of the Lower River crop. A detailed survey of the pest situation there has been carried out and the problem is now clearly defined.

2. Routine records of bollworm and stainer populations, crop development and analysis of crop loss have been made on the Domira Bay Station and in the native crop of the Lake Shore area, and in 35 native gardens, sampling six of the main areas of the Lower River.

3. Detailed records of the eco-climate of the crop have been taken for comparison with standard climate records at a number of key points. Soil temperatures and moisture contents have also been recorded.

4. On the Domira Bay Station crop development and crop loss studies have been made by plant diagrams on 96 plants, using three and one plants per hill, and this method compared with bulk taggings of flowers.

5. Bulk taggings on a complete range of planting dates and on a variety trial have been made at Chiromo sub-station in the Lower River, tracing in detail development and sources of loss of crop.

6. Pupation cage work on red bollworm has been continued at Domira Bay (Lake Shore), Balakas (Central Shire), and Chiromo and Port Herald (Lower River). Balakas has now been closed in favour of two sites tapping further ranges of Lower River conditions.

7. Experiments in the Lake Shore area on depth of pupation show that this increases from a mean of 1″ in March to 2½″ in June. Direct sampling of cotton fields confirm that pupæ are in the surface layer of soil: about 2,000 per acre were found in diapause in November.

PROGRAMME, 1940-41.

1. Routine field records on red bollworm egg-laying and larval populations, stainer populations, crop development and crop loss will be continued on the Domira Bay Station, in native gardens in the Lake Shore area, and at the same points as last season in the Lower River. In addition, similar records will be started in that portion of the Lower River where no cotton-growing was allowed last season.

2. Routine pupation cage work on red bollworm will continue on an increased scale.

3. The effects of larval food and of different humidities during the pupal stage will be studied in relation to the inception of diapause.

4. The tolerance of active and diapausing pupæ to water-logging will be investigated.

5. Records of crop climate and soil conditions will continue, with particular reference to cool season inhibition of pest activity. These will be supported by insectary studies on stainer breeding.

6. The analysis of crop development and crop loss will be repeated by bulk taggings and by plant diagrams on the Chiromo sub-station.

7. Recording of stainer populations on wild host plants in the Lower River will be started.

NIGERIA.

PROGRESS REPORT FROM THE CORPORATION'S SEED FARM, DAUDAWA, 1939-40.

BY
G. BROWNE.

Introduction.

By the time this report is in print, Daudawa Seed Farm will have been 15 years in existence. Its chief purpose has been the multiplication of selected strains of cotton made by the Agricultural Department's Botanist at Samaru. Besides this work, certain large-scale field trials have been carried out in recent years. About one-ninth of the farm has been taken over by Settler farmers who have gone in for mixed farming under the supervision of the Corporation's staff and who also grow cotton from seed issued to them each year. As the seed issued is the same as that grown on the Main Farm, their crops of seed cotton are bought by the Corporation at local market prices. The bulk of the cultivation on the farm is done by cattle, and a good deal of work is consequently devoted to the supply of fodder and other foodstuffs in order to keep the animals in good health and to ensure a plentiful supply of manure. Rapid strides have been made in recent years in anti-erosion measures.

As usual, this report is written in mid-season and therefore of necessity, reference is made both to the harvesting of the 1939–40 crops, and to the growing period of the current season (1940–41) to date.

Below is given a summary of the comparative acreages under crops during the past two years :—

Main Farm.	1939–40	1940–41
Land occupied by Settlers...	97 acres	97 acres
Land left for Settlers' extension (Grass)	40 „	38 „
Farm Buildings, Stores, Ginnery etc.	5 „	5 „
Area under Cotton	341 „	320 „
„ „ Guineacorn	122 „	137 „
„ „ Mucuna Beans	—	40 „
„ „ Pigeon Peas	80 „	60 „
„ „ Sweet Potatoes	20 „	28 „
„ „ Groundnuts	—	20 „
„ „ Grass	195 „	155 „
Total area of Main Farm	900 „	900 „
Co-operative Site.		
Number of Settlers	12	12
Estimated area of land they occupy	120 acres	120 acres
Anti-erosion Measures.		
Area of land treated	410 acres	530 acres

Meteorological Notes.

The rains began in mid-April in 1940 and lasted until November. June rainfall was very good indeed and the cotton crop, the planting of which commenced on June 28th, got away to a good start. The rain in July was about normal, but the falls of August and September were 4 inches and 3 inches respectively below the average for the last 9 years. This apparent lack of rain had no deterrent effect on the cotton, except that in some cases supplies were rather difficult to get established. On the contrary, it allowed weeding and other cultural operations to be kept well up to date. It is the October rains which have the most important influence on the cotton crop, and these have been excellent and it can now be said that the crop looks most promising, even although the rainfall to date is only 38·99 inches as against an average over the past 9 years of 46·54 inches. The only result of this rain shortage will most likely be an earlier crop, though this depends very largely on what rain falls in the latter part of the season. On the whole, 1940–41 can be considered to have been a very satisfactory season so far as meteorological conditions are concerned and one which helps to prove that a heavy rainfall is not really essential to successful crop production. It is the incidence of rainfall which really matters rather than the total amount.

Cotton.

Season 1939–40.—As recorded in last year's Report, of the total area sown in cotton on the Main Farm last season, 220 acres comprised the bulk crop of Daudawa 38 cotton—the seed being from the previous year's D.31 (AC) Strain. In addition to this 220 acres, a further 210 acres were in the same strain of seed, this being the land under cotton on the Settlers' and Co-operative Farms.

A manurial trial in Field 8 was also made with Daudawa 38 strain, the area being 12 acres. In the permanent yield trial of current strain *versus* B.C.G.A. Ordinary, 4 acres were Daudawa 38—being, of course, the bulk current strain, and the other 6 acres were in B.C.G.A. Ordinary. One 20-acre field was sown in D.8, a strain which hailed from Maigana last year, the lint of which had the highest broker's valuation, but, unfortunately, it was not possible to give it a very good field owing to previous cropping arrangements. Lastly, 60 acres were sown in Maigana 38 strain which had been grown at Maigana in the previous year.

Details of the season up to the end of October, 1939, were given in last year's Report.

Damage by aphis and bollworm was about normal, but there was

rather more stained cotton than usual, this occurring mostly in the earlier-planted fields. There was little shedding, and one instance of stem borer, the latter only covering an area of a few square yards.

The annual cotton pickers from French Territory and Sokoto Province arrived in December and picking began on the 28th of that month. For the first time—owing to the higher price paid for cotton locally—day and night guards were detailed to patrol the farm. (Local markets opened at 0·8d. per lb. and quickly rose to 1·4d.) The crop ripened very quickly indeed and large numbers of pickers had to be engaged in order to prevent the seed cotton from spoiling on the plants.

It was very soon evident that record yields would be obtained from some fields and this was later confirmed by the final figures. The area planted in cotton on the Main Farm produced 108,847 lb. of No. 1 Grade seed cotton and 3,035 lb. of No. 2 Grade, an average throughout, including No. 2, of 328 lb. seed cotton per acre, which is easily a record for Daudawa. The highest average yield for any one 20-acre field was 485 lb. per acre which again beats all previous records. The average yield per acre for the cotton crop over the last 10 years—not including the season 1939–40—is 216 lb. per acre and the highest average individual field yield (20 acres) over the same period was 329 lb. per acre. Further, in 1939–40, there was one block of 60 acres, Maigana 38 strain, which yielded an average of 469 lb. per acre over the whole area. This again is by far the highest average yield per acre ever recorded here, even on one 20-acre field. There is little doubt that these increases in yields are due to the system of grass-fallowing which was begun about three years ago, and also to the anti-erosion measures which started about the same time.

The bulk strain on the Farm, *i.e.*, D.31 or Daudawa 38, as it is now called, of which there were 255 acres, gave an average yield of 308 lb. per acre. Owing to force of circumstances, a 20-acre field which had just been treated for sheet erosion had to be allocated to the D.8 Strain and consequently gave an average of only 152 lb. per acre, all No. 1 grade. In the experiment of current strain *versus* B.C.G.A. Ordinary, the 4 acres of Daudawa 38 produced 1,699 lb. of No. 1 grade cotton and 123 lb. of No. 2 grade, an average of 455 lb. per acre. The 6 acres of B.C.G.A. yielded an average of 354 lb. per acre, all first grade.

The 12 acres plot on which the manurial trial was carried out was also in Daudawa 38 and yielded 303 lb. per acre.

It was estimated that the Settlers and the Co-operative Farmers had 196 acres under Daudawa 38 strain on their respective farms and from these 48,417 lb. of No. 1 and 2,751 lb. of No. 2 grade seed cotton were

obtained ; an average of 261 lb. per acre. The highest individual yield on any one farm was from 5 acres planted in Farm E.1, which gave an average of 437 lb. per acre. The prices paid to the farmers were the same as those paid in local markets and increased from 0·8d. per lb. to 1·4d., falling later in the season to 1·1d. In view of the good ruling prices, no bonus was paid to the Settlers this season.

As has been the practice for the past few years, the whole of the bulk crop was ginned at Funtua ginnery. This ginnery is equipped with modern blast gins and turns out a sample of lint ginned under commercial conditions from which comparisons as to its quality and value can more fairly be obtained than from cotton ginned on the small gin at Daudawa. The bulk crop of Daudawa 38 seed cotton from the Main, Settlers' and Co-operative Farms gave a ginning outturn of 35·6 per cent. The following strains were all ginned at Daudawa :—Maigana 38 strain—ginning outturn 36·4%, D.8 strain—36·45%, and B.C.G.A. Ordinary, 31·8%. All the foregoing outturns are calculated on No. 1. grade only. The No. 2 grades are mixed with hand-pickings and ginned here after all the other ginnings are over.

The lint was sent to England through the B.C.G.A. for valuation and subsequent sale in the usual way. The following valuations are based on July American Futures @ 7·50d. :—109 bales of Daudawa 38 (bulk crop, ginned at Funtua) were valued at 40 points on and described as " Strict Good Middling to Mid Fair, Staple 1″ to 1 $\frac{1}{16}$″, irregular " ; 4 bales of B.C.G.A. Ordinary from the permanent field trial of current strain *versus* B.C.G.A. were valued at 25 points on, referred to as being " Strict Good Middling, creamy colour, Staple $\frac{7}{8}$″." The 7 bales of D.8 lint were valued at 40 points on and the broker's report described them as " Strict Good Middling, Staple 1 $\frac{1}{16}$″, creamy in colour." Maigana 38 lint, of which there were 59 bales, was valued at 25 points on and described as " Good Middling, creamy colour, Staple about 1″, irregular, rather weak." In all the reports on the lint ginned at Daudawa reference is made to its creamy colour. This is due to the fact that the Funtua gins are of the blast variety and the Daudawa ones are not.

The seed from the bulk crop of Daudawa 38 ginned at Funtua all went to the Awai District where it was mixed with the seed from the previous year's crop and then re-issued in that area. The D.8 and the Maigana 38 seed—both ex Daudawa—were mixed with two small lots of seed sent from Bomo and Maigana respectively to form the bulk strain for the 1940–41 season. The seed from the B.C.G.A. Ordinary and other small quantities of damaged seed were used as cattle fodder.

Season 1940–41.—This year planting began on June 28th under excellent conditions, but two short dry spells during July tended to hold up planting, and the sowing of the area of 320 acres under cotton on the Main Farm was not completed until August 1st. Spacing was the same as usual, *i.e.*, 18″ between stands on ridges 3′ apart, and the seed rate was 10 lb. per acre (about 5 or 6 seeds per hole). The seed this year for the Bulk crop was a mixture of four different kinds, two of which—representing 92% of the whole—were grown at Daudawa. The components of the mixture were as follows :—D.8 ex Daudawa, Maigana 38 ex Daudawa, D.30 ex Maigana and D.30 ex Bomo. This mixed seed will now become "Daudawa 39." In addition to the foregoing, there are 30 acres of D.8 ex Maigana and another 30 acres of D.30 also ex Maigana.

The Settlers' and Co-operative farms were all sown in bulk Strain, and the estimated area under cotton on all these farms is 224 acres, made up as follows :—Settlers on Main Farm, 56 ; Settlers on Co-operative Site, 82 ; Co-operative (hand) farmers, 86 acres.

The only field trial in progress this season is the permanent one of current strain *versus* B.C.G.A. Ordinary in Field 36. Germination was very good and all the cotton got a good start although, as has already been stated, "patchy" rainfall in July held up sowing and also supplying in that month. August had an unusually light rainfall, but, whilst it was sometimes difficult to get supplies established, the weather was excellent for weeding and other forms of cultivation, and this, together with the fact that there was more sun than usual, probably accounts for the particularly healthy appearance of the crop this year. The stand is very good indeed except in part of one field where supplies could not be established owing to dry periods and light ground. Flowering and fruiting have been very heavy and begin well down the plant. So far as could be seen there was very little evidence of insect pest damage up to the end of October when this report was written. On the whole the rainfall has been lighter than usual this year, but the incidence could hardly be improved upon—except in July—and at the time of writing the crop looks full of promise.

Other Crops.

Guinea-corn, 1939–40.—The area under guinea-corn dropped to 122 acres last year and this produced an average of 773 lb. per acre. Although this yield is not very good it was an increase of 134 lb. per acre on the previous year's average. The highest yield per acre in any one (20-acre) field was 1,158 lb. of thrashed grain. The usual close spacing of 18″ in rows 3′ apart was used again. The thrashing machine

again did its work without incident and must already have saved well over its original landed cost.

1940–41.—In the present season 137 acres have been sown in this crop, the spacing being the same as last year. The land was manured at the rate of 2 tons per acre before planting, which began on May 4th, rather later than usual. Weather conditions following planting were good and in all cases there is every promise of an excellent crop, provided that there is no locust attack ; the season has been completely free from this pest so far.

Sweet Potatoes, 1939–40.—The usual difficulty was experienced in obtaining sufficient seed to plant the 20-acre field which was allocated to sweet potatoes last year. The planting occupied three weeks, from July 24th to August 17th, and the crop was later weeded. The total weight of *dried* potatoes from this area was 11,752 lb., an average of 587 lb. per acre. The potatoes were fed to the stock after they had been steeped in water for some hours.

1940–41.—28 acres have been planted in sweet potatoes and again there was great difficulty in obtaining supplies of seed, which, for the most part had to be bought locally.

Mucuna Beans.—No definite area was sown in mucuna last year but odd patches of land were used for this crop, and these ran into quite a considerable acreage. The herbage was dried, mixed with haygrass and stacked for fodder. This year 40 acres have been sown in Mucuna besides various small areas of land up and down the farm.

Pigeon Peas.—One field of pigeon peas which had been in existence for three years was dug up and the land put into crop. The other three fields, *i.e.*, 60 acres, will be dug up this year and other crops sown down in them.

Groundnuts, 1940–41.—No groundnuts were planted on the Main Farm last year but one 20-acre field—which has always previously suffered from erosion but which was broad-base-terraced three years ago—was planted in this crop on June 20th this year and is producing what appears to be a first-rate crop.

Haygrass.—The total area under haygrass is roughly the same as last year. Harvesting work this year has been held up owing to the long time taken in obtaining spares from home for the cattle-drawn machine, which, up to the time of writing, has not been in operation at all. Consequently the whole of the work has fallen on the trailer-mower, which also broke down. New parts were improvised to enable the work to proceed pending the arrival of others from home. The haygrass crop this year is by far the heaviest yet seen here, and in some parts more closely resembles grass crops in England, the herbage

in the bottom being really dense. Good supplies of fodder and bedding are assured.

English Potatoes.—In order to assist internal food production and at the request of the Director of Agriculture, some 2½ tons of seed potatoes are to be planted by the side of the Sokoto River near to the pump house, as an irrigated dry season crop. Preliminary work of clearing away long grass. etc., has already been completed.

Field Trials.

As was reported last year, the site for the permanent trial of the current strain of cotton *versus* B.C.G.A. Ordinary was moved to Field 36, where the lay-out was the same as that used in previous years, *i.e.*, alternate acre strips of current strain and B.C.G.A., the whole being bounded by 5-acre strips of guinea-corn. Current bulk strain last year was Daudawa 38 (D.31) and this showed 12·5% increase over B.C.G.A. In the present season the trial is the same as before, the only difference being that the current strain this year is Daudawa 39, particulars of which have been given above.

The other field trial which was referred to in the last annual report was that in which an attempt was being made to find out whether the use of imported manures—in this case superphosphate—was justified when used, (*a*) alone, or (*b*) in conjunction with various dressings of farm yard manure. It should be noted that this trial was one of local interest only, and was intended to provide some information in the event of certain eventualities arising. The layout of the trial was the same as the previous year, but the treatment of the plots was different, as will be seen from the accompanying table.

Plot.	*Treatment.* 1938–39.	*Treatment.* 1939–40.
1	No manure	75 lb. Superphosphate p.a.
2	1 ton F.Y.M. p.a.	1 ton F.Y.M. p.a.
3	2 ,, ,, ,,	2 ,, ,, ,,
4	67½ lb. super. p.a.	No manure
5	67½ ,, ,, plus 1 ton F.Y.M. p.a.	1 ton F.Y.M. p.a.
6	67½ ,, ,, plus 2 ton F.Y.M. p.a.	2 ,, ,, ,,

The results in 1938 were inconclusive and in 1939 were almost equally so, at all events as regards the effect of superphosphate. In fact, from the comparative yields it would appear that the residual effects of F.Y.M. from the previous year showed the most important increases, the difference in yields between dressings of one and two tons to the acre being insignificant, though slightly higher in the latter case. Combinations of superphosphate with different dressings of F.Y.M. showed no appreciable improvement in yield and there seems to be little if any residual benefit from last year's application of superphosphate. No. 1 plot, on which there was no manure in 1938, and which, owing to

a misunderstanding, had a slightly increased application of superphosphate in 1939, showed good results and it is a pity that various rates of the dressing of the artificial manure were not tried. On the whole it would appear that, judging from the results of this particular trial, it does not seem worth while importing artificial manure when such good results are obtained from the use of F.Y.M. which is so easily obtained by the Mixed Farmer.

Cattle.

In October last year the herd consisted of 225 head of stock, made up as follows :—142 working bullocks, 42 cows and heifers, 23 bull calves and 18 heifer calves. This year there is a reduction of 8 head, the total number of stock being 217. This reduction is mainly due to the smaller number of calves born, only 8 having been born during the year. The comparative figures this year are :—150 working bullocks, 48 calves and heifers, and 19 calves. A serious loss in young stock was 5 calves from hæmorrhagic septicæmia and 1 from snake bite. Exchanges to Settler Farmers accounted for 5 working bullocks, but 10 other bullocks have been bought as replacements. Altogether 9 other animals died from various causes, no two of which were the same and were accidents for the most part. Only one died of trypanosomiasis.

The health of the herd has been fairly good throughout the year, but, owing to lack of sufficient concentrates, the working animals got down in condition after last season's cultivation period. This time of year always tries them, and it happens to be the very time when stocks of cotton seed are at their lowest. Extra seed was bought and with careful feeding and handling, the animals were got back into condition. So far as actual disease is concerned, there has been nothing except the outbreak of hæmorrhagic septicæmia mentioned above. Injections of anti-hæmorrhagic septicæmia serum were given and the throats, mouths and nostrils of the remainder were washed out daily with a weak Dettol solution. No more cases appeared. Two sheds have been built in mud and in these old cattle are stall-fed into condition for killing. Other cattle which have got down in condition are also fed in them, and when their health has improved they are turned out with the rest of the herd again. The stall-feeding of such animals has proved a great success from both points of view. At the time of writing this report the herd as a whole are in good condition.

Anti-erosion Measures.

This work has been proceeded with during the past twelve months and there is no doubt as to its beneficial effect on the fields so treated.

The pre-wet season's programme has not yet been quite completed, but will be finished within a month, now that a slacker period on the farm has come round and labour is available. 120 acres will then have been added to the 410 acres treated in previous seasons, making 530 in all. A rough method of levelling the bed of the terrace itself whilst the work is going on has been devised, and this does away with most of the small inequalities which tend to hold up water during a heavy rainfall, thus causing washouts.

Labour.

Economy has been exercised in the amount of labour employed and efforts have been made to have just enough labour to run the farm and no more. Short time has been worked with the object of keeping men on and supplies have therefore been available when required. There were three deaths during the year, all being old members of the staff:—the second Chief Headman, the Head Mason, and the Storekeeper. The health of the camp has otherwise been good.

Settlers' Farms.

No new farmers have been set up during the past year and the period has once more been one of consolidation. The farmers were advised to include mucuna beans for fodder and groundnuts as an alternative cash crop to cotton this year. This measure ought to make them less dependent on outside grazing for the maintenance of their cattle in good health. The groundnut tops form another valuable source of food for the cattle and are usually mixed with the haygrass in the fodder stacks. The steps referred to in the last annual report which it was hoped would ensure increased cotton yields were highly successful and will be repeated this year. Owing to the higher repayments of debts, it is hoped that two, if not three, of the farmers on the Main Farm will be completely clear of debt before March next year, if yields are as good as seems probable. This should have a stimulating effect on the others. Five cattle have been lost from one reason or another—mostly by accident and wholly among the Co-operative Settlers—and these have been replaced from the Corporation's herd.

Water-works.

A good deal of trouble has been experienced with the pump, which is undoubtedly getting a little old. New plungers have been fitted and also new suction valve seats. These have had good results and now a forced-feed lubricating pump has been fitted. This ought to obviate the shortage of lubrication in the steam cylinders, which has been a cause of trouble.

Building Work.

No new buildings of a permanent nature have been erected during the year and only one of a semi-permanent type. This is a small mud-built shed, containing two pens, at the Farm Store site, which has been mentioned in the section dealing with cattle. The masons have been engaged entirely on maintenance work, and have been laid off for short periods. A culvert-cum-bridge was built on the new road to the pump-house. This road cuts off 3 miles on the return trip for the wood carts.

General.

The present season's cotton crop, not only at Davdawa but elsewhere in the countryside, looks like being a record. Late rains have been good and never has the crop, as a whole, looked more healthy and promising.

During 15 years of close contact with farming in this and the neighbouring Provinces, the most remarkable feature to be noticed is the vast improvement in general agricultural practice, not only round this and other agricultural stations, but at long distances from them. This is most significant and exceedingly hopeful for the future of Nigeria.

After these many years of happy association with several Government Departments, the Manager wishes to thank particularly, both on the Corporation's behalf and also his own, the members of the Administrative, Agricultural, and Veterinary Services for their close co-operation and helpfulness during that period.

In view of the fact that the Corporation are handing over the Daudawa Seed Farm to the Agricultural Department in April, 1941, it was thought fitting that the Director of Agriculture should be asked to give some idea as to its future development under his administration.

THE FUTURE OF DAUDAWA.

BY

THE DIRECTOR OF AGRICULTURE.

The future of Daudawa, like that of most things, is, of course, dependent on the course of the war, and unless it is called upon to assist in the campaign for the production of food it is unlikely that its scope and function will be greatly changed until after the war.

If it is possible to assume that things will return to some degree of normality when the war is over, then there is no doubt that Daudawa will play an important part in the development of agriculture in Northern Nigeria. It will probably become the headquarters of

a Principal Agricultural Officer who will have under him specialists who will devote most of their time to cotton problems. That is to say it will be both an administrative headquarters and a research station. But its present function as a seed multiplication farm will always remain, although it is likely that the work of multiplication will be increasingly carried out by settlers. The final picture will be that of a research farm surrounded by thriving settlers who will multiply the strains evolved by the specialists and also put into practice such improvements in cotton cultivation as they may recommend. Such an arrangement would be ideal, for if the work of the specialists is sound, the settlers will gain, and the economic position of the settlers will be the measure by which the results of the research will be judged.

Included by courtesy of the Nigerian Government.]

NIGERIA.

PROGRESS REPORT ON WORK ON COTTON IN THE NORTHERN PROVINCES FOR THE SEASON 1939-40.

BY
F. O. T. JAMES.

Introduction.

A number of introductions were made during the season and they are still in the observation stages.

Meteorology.

Rainfall for the year, though below average, was satisfactory. a fall of 2" in October helped to increase the cotton crops.

Genetics and Breeding.

The breeding work on the three high-yielding strains, D.5, D.8, D.30, was continued. Trials of these three strains, their mixtures and their derivatives, were carried out at Samaru, Bomo and Maigana. The " Maigana " mixture, which is a 50 : 50 mixture of D.8 and D.30 gave a 53 per cent. increase in yield of lint over Standard at Bomo, and 42 per cent. over Standard at Maigana. The " Samaru " mixture, a mixture of D.5, D.24, D.8 and D.30, gave a 46 per cent. increase in yield of lint over Standard at Bomo, and " Awai," a 50 : 50 mixture of Ordinary Allen and D.31 derivatives ex Daudawa 1938, gave an increased yield of 15 per cent. lint over Standard at Maigana. D.5, D.8, D.30, and their various derivatives also gave yields varying from an increase of 35–77 per cent. over Standard—(Ordinary Commercial Allen).

Spinning results on these strains have not yet been received.

Entomology.

The ratooned cotton experiment mentioned in last year's Report was discontinued as it became apparent that for entomological reasons the ratooned native cotton cannot supplant Allen in this part of Northern Nigeria.

Summary and Conclusion.

This season's results have confirmed the results of the past three years in respect of the high yielding strains. It is also expected that their various mixtures and derivatives will in due course also produce high-yielding strains of better quality than the mother-strains.

PROGRESS REPORT ON WORK ON COTTON IN THE SOUTHERN PROVINCES FOR THE SEASON 1939-40.

Introduction.

Work on cotton continued to play a minor role in the plant breeding programme of Southern Nigerian crops.

Meteorology.

During the season the rainfall for the period July–December was 20·34 inches—3 inches less than the previous five-year average. Though this shortfall was not great, the distribution within the period was irregular. A shortage of rain occurred during the early growing period, and heavy showers during bolling seriously reduced the crop.

Genetics and Breeding.

It was found desirable to modify the programme of breeding and selection during the season. Attempts to get a smoother lint from Ishan A by hybridisation with Sea Island were not achieving any results, and we were therefore particularly grateful to Mr. J. B. Hutchinson, Head of the Genetics Department of the Corporation's Research Station, Trinidad, for his advice to discontinue this line of work, and to concentrate on Ishan A selections. He also suggested improvements in our routine for doing so. Unfortunately this advice arrived after the selection plot had been planted, and there was therefore little to be done beyond discarding all the Sea Island hybrids.

In this connection Mr. Hutchinson wrote as follows :—" It seems to me that there is good evidence for believing that the correlation between roughness (of lint) and hairiness which is necessary for pest (jassid) resistance, is so close that it either cannot be broken or will need the expenditure of a great deal more time and money than you can afford."

Entomology.

During the 1938–39 season considerable damage was done by *Helopeltis*, but in the 1939–40 season the damage caused by this pest was disastrous. The attack was general on the plantation, wiped out the multiplication plot, seriously affected the Ishan A plants in the selection plot, and caused yields as low as 4½ lb. seed cotton per acre on the farm. Only by constant hand picking were the plants in the selection plot saved at all.

Summary and Conclusion.

Work on the Ishan×Sea Island hybrids has ceased. It was not possible to adopt Mr. Hutchinson's suggestions in full for the routine of Ishan A maintenance owing to the arrival of his advice after planting had already taken place and owing to the serious damage caused by *Helopeltis*.

PROGRAMME OF WORK FOR THE SEASON 1939-40.

Maintenance of Ishan "A".

(i) It was not possible to get sufficient selections from the last season's plot to start work as proposed on the line suggested by Mr. Hutchinson. This year, a number of selections is being bred from which ample material will be available for this purpose.

(ii) Selection and multiplication plots are isolated by extensive protective belts of *Tephrosia Candida* in order to limit the incidence of *Helopeltis* which proved so disastrous during the previous season.

(iii) Multiplication of seed continues as in the previous years.

(iv) Selections of rough strains of Ishan will be made from plants growing in Ishan Division of Benin Province.

WEST INDIES.

TRINIDAD COTTON RESEARCH STATION, GENETICS DEPARTMENT.

PROGRESS REPORT FOR THE PERIOD OCTOBER, 1939—OCTOBER, 1940.

BY

J. B. HUTCHINSON, R. A. SILOW AND S. G. STEPHENS.

INTRODUCTION.

From October, 1939, to the end of May, 1940, J. B. Hutchinson spent about two-thirds of his time on work for the Agricultural Department, Trinidad. During June, July, and August, J. B. Hutchinson and S. G. Stephens were absent on leave in Canada and the U.S.A. The experimental programme has been carried out in full, but the analysis and writing-up of the data collected have been considerably delayed.

The 1939–40 crop season was a favourable one, and good weather and the effect of the 1939 close season resulted in a satisfactory crop of comparatively clean seed cotton. Pink bollworm infestation was light until late in the season, and boll rots caused little damage. A considerable attack of stainers was feared, but did not reach serious proportions. *Sacadodes* bollworm was common at the latter end of the crop.

GENETIC RESEARCH.

Developmental abnormalities.—Harland's conclusion that there are different normal alleles of crinkled distinguishable by differences in dominance potency has been supported in part. Making use of the linkage with green lint to identify normals of different origin, it has been shown that the normal alleles in Upland and Sea Island are different. On the other hand, Harland's statement that Meade normal differs from Triumph normal has been disproved.

Experiments with Meade × Meade crinkled have confirmed last year's results and demonstrated important environmental effects on dominance. Dominance of normal over crinkle appears to be the exception rather than the rule in *G. barbadense*. Some progress has been made with attempts to measure the effect of dominance modifiers on the normal phenotype, but it is clear that such effects are small and

elusive, and will only be demonstrable in particularly favourable material. That some modifiers are highly specific is shown by the fact that improvers of contorta have no effect on crinkled, which is a member of the same allelomorphic series. Mutation from contorta to normal and from crinkle to normal has been observed in $cr^{C}cr^{D}$ heterozygotes.

In addition to " Round Leaf " the following abnormalities are now known to be independent of the crinkle series :—

Glabrous dwarf	... ...	Simple gene **Dg–dg.**
Nigerian rogue	... ...	Probably three genes.
St. Joseph Crinkled	... ...	Apparently duplicate cr^{I}.
Columbian rogue	... ...	Inheritance complex.
Moco short bract	... ...	Probably double recessive.

A plant with an abnormal mutant sector was found in Dr. Mason's Sea Island material. Flowers on the mutant sector were female sterile, and produced very little pollen indeed. One hybrid plant was obtained by pollinating normal Sea Island, and is apparently normal.

Corky has been found in interspecific hybrids other than those between Bourbon and Sea Island V.135 cottons. Corky segregates were found in backcrosses of *G. thurberi* to *G. barbadense* V.135 and in backcrosses of *G. raimondii* to *G. barbadense* V.135. The Sea Island modifier complex is apparently favourable to the expression of the corky character since cork production is intensified when Sea Island is used as the recurrent parent both in Sea Island × Bourbon and Sea Island × *G. thurberi* crosses. On the other hand when Bourbon was used as the recurrent parent, no corky segregates could be isolated in the first backcross.

The distribution of a corky gene carried by Bourbons has been tested by crossing a series of Bourbons with Sea Island V.135. In general it has been found that when West Indian Bourbons were crossed with V.135, corky hybrids were obtained, but when South American Bourbons were crossed with V.135 the hybrids were normal.

Leaf shape.—In its main features this experiment is now completed, but data are still being accumulated with regard to the wild types *G. tomentosum*, *G. taitense*, and *G. darwinii* (broad leaf type). Results so far indicate that there are only four main leaf shape genes in New World (2n=52) cottons. These form a series of multiple allelomorphs. A marked difference is found in the distribution of these genes between the two main species, *G. hirsutum* and *G. barbadense*. While three of the four genes occur commonly in the former species, possibly the only one present in *barbadense* is Sea Island leaf shape. Considerable

differences were found between the leaf shape modifier complexes of the various species. Two mutants affecting leaf shape were found in a large F_1 of superokra × okra Upland.

Genetics of lint density.—Much of this season has been devoted to the study of the quantitative effects of certain genes affecting lint density, which were originally identified and isolated by means of their effect upon the "Wagale" lintless mutation. This investigation is an excellent example of the way in which an experiment may start off from a purely academic viewpoint and eventually throw significant light upon problems of widespread practical interest. Some two years ago the experiment had reached the point where there was definite information that the genes which modify the expression of the $\mathbf{h_ah_a}$ phase of the lintless gene also affect the heterozygous $\mathbf{H_ah_a}$ phase, though to a lesser degree. The effect of the lintless modifiers on the $\mathbf{H_aH_a}$ phase had not been investigated, but as evidence was available that this phase was at any rate capable of modification, it was decided to continue the investigation in this direction. The experiment was also so planned as to give information on the dominance relationships existing at the modifier loci, and on the interaction between modifiers at different loci. Thus it was hoped to gain experimental evidence with a direct bearing on the inheritance of quantitative characters, as well as on Rasmusson's interaction hypothesis, which is itself the most notable recent contribution to the theory of quantitative inheritance, and which, in a paper from this Department last year (Silow, *J. Genet.* 38, 229), was extended and incorporated with the gene potency concept to cover the manifestation and modification of dominance. The results have not yet been fully analysed, but it is clear that the two minor genes concerned in the material are of approximately equal potency, and the interaction between these genes at different loci is also of low degree and strictly comparable with that which occurs between pairs of these alleles at the same locus. Their effects at the higher levels of expression covered by the $\mathbf{H_ah_a}$ phase of the main gene are also considerably less than in the lower range covered by the $\mathbf{h_ah_a}$ phase. All these findings are in accordance with the interaction hypothesis of quantitative inheritance, and with its extension to cover dominance, from which it had been forecast that a gene of low potency relative to the total possible expression of a character would exhibit little dominance. On the other hand, the $\mathbf{H_a}$ gene, which is similar to the modifiers in that it affects the same character in much the same way but to a considerably greater degree, shows considerable dominance. On the interaction hypothesis the effects of these minor genes would be expected to be at their minimum in the duplex $\mathbf{H_a}$ phase (the highest range of expression) and

in the relatively few plants of this genotype which occurred in the families investigated no significant effects could be discerned.

Cytology and the effect of colchicine.—The experiment commenced with the artificial production of polyploids by means of colchicine treatment. The preliminary results have been reported elsewhere. (*Trop. Agric.* February, 1940.)

The polyploids obtained, viz. : tetraploid *G. arboreum* (n=26), and hexaploid *barbadense* × *raimondii* (n=39) have been used as a basis for interspecific hybridisation. The tetraploid *G. arboreum* has been found to cross readily with several other species, although when left to open pollination in the field it is fairly sterile (twenty plants set an average of one boll per plant during a whole flowering season). The following hybrids have been obtained :—

Tetraploid arboreum ♀	×	*G. raimondii*	♂ (n=39)
,,	×	*G. armourianum*	♂ (n=39)
,,	×	*G. aridum*	♂ (n=39)
,,	×	*G. sturtii*	♂ (n=39)
,,	×	*G. barbadense*	♂ (n=52)
,,	×	*G. hirsutum*	♂ (n=52)
,,	×	*G. tomentosum*	♂ (n=52)

Crosses were attempted unsuccessfully with diploid *G. arboreum*, *G. thurberi*, and *G. davidsonii*. The (n=52) hybrids have proved to be completely sterile. Crosses have also been attempted between the hexaploid *G. barbadense* × *G. raimondii* and Asiatic (n=13) species in the hope of synthesizing a (n=26) type of similar constitution to the naturally occurring (n=26) types. This has not been successful so far. Backcrosses have however been obtained to *G. barbadense*. The backcross plants proved to be tetraploids (n=26) instead of pentaploids as expected. They are quite fertile and thus a means is provided for transferring *raimondii* characters to the *barbadense* genotype. The production of diploid instead of triploid gametes by the hexaploid is being investigated cytologically.

Interspecific hybrids.—Work on the interspecific hybrids involving the wild *Gossypium anomalum* has been brought to a close, and during the period under review the results have been written up and submitted for publication. It has been possible to compare the genetic structure of this species with that of the cultivated Asiatic species *arboreum* and *herbaceum* with respect to eight characters involving fifteen main loci and their associated minor genes. All three species carry alleles at each of these main loci, and in these the two closely related species *arboreum* and *herbaceum* differ hardly at all, though their modifier systems are quite distinct. Taxonomic criteria and the sterility of its

hybrids indicate that *anomalum* is much further removed from the two cultivated species than they are from one another. Genetically this species shows considerable divergence from the cultivated Asiatic cottons in its main loci, and whilst in a few cases its minor genotype is near that of either one or other of the cultivated species, in most cases it also is very distinct from both. The genetic situation in the three species appears to be a further development of the type of incipient speciation which is seen in the geographic differentiation which occurs within the species. As a result of this investigation genetic support can now be given to the contention, hitherto based chiefly on cytological grounds, that the diploid species are themselves derived polyploids. Turning to economic lint characters, exactly the same type of gene appears to be responsible for the difference between *anomalum* and the cultivated cottons as is responsible for the differences within the cultivated species themselves. Their lint was not acquired at a single step, but was probably built up gradually. It was concluded that such types as *anomalum* are not likely to be of any value as a source of lint length or ginning out-turn genes, though it might be worth paying attention to this species as a source of lint fineness.

Work in connection with other Stations.—The collection of data on the spinning value and hair characters of Sea Island cotton has provided valuable information on environmental variation in a genetically uniform strain. Differences in maturity, hair weight and standard hair weight are very closely bound up together. From variety trial results the yield behaviour of the main Sea Island strains and their reaction to seasonal variations are becoming clear. The information now accruing from the testing of Sea Island material is proving of great value in guiding cotton-growing policy.

Other experiments.—The results of a grafting experiment carried out this season with standard cotton varieties revealed unsuspected effects of stock on scion. The persistent Sea Island type when grafted on an annual Upland stock showed more vigorous early growth, earlier flowering and an earlier peak to the bolling curve than when grafted on its own stock. On the other hand its persistency and number of bolls produced over the whole season was little affected. Reciprocal grafting (*i.e.*, Upland scion on Sea Island stock) showed a reverse and even more marked effect. Early growth was retarded, but in time Upland scions on Sea Island stocks overhauled and finally surpassed the controls (Upland scions on Upland stocks). Onset of flowering was delayed by about a week, and the peak of the bolling curve occurred over a month later than in the controls. In spite of this, the total number of bolls produced over the whole season was little affected. The

Sea Island stock tended to increase the persistency of the Upland scion.

A small scale parallel experiment designed to test the effect of scion on stock, showed that root size was almost entirely governed by the type of scion grafted upon it. There was evidence that the root/shoot ratio was changed by grafting, to near that typical of the strain used as scion.

It was concluded that for general purposes (especially persistency) the Sea Island strain at present in use as a stock at this Station is the best, but that where rapid early growth and early flowering is required, an Upland stock would prove superior.

Publication.

Hutchinson, J. B. & Silow, R.A. 1940. "Gene symbols for use in cotton genetics". *J. Hered.* 30, 461.

PROGRAMME FOR 1940-41.

It will be readily understood that a genetics programme only changes slowly. Considerable progress has been made with the programme laid down in the 1938–39 report, but it remains the basis of work for the 1940–41 season, so repetition is unnecessary.

Summary.

The most important work of the Department in the near future will be the analysis and writing up of data. The collection of data on classification has been complete for some time. Information available on the crinkle series warrants further publication. The genetics of *G. anomalum* has been written up for publication, and papers on the inheritance of lint colour and on the behaviour of factors affecting ginning capacity in Asiatic cottons are in course of preparation.

The wide range of developmental abnormalities in New World cottons, and the tendency in all cottons studied for the genes to be arranged in long allelomorphic series, are points of great interest. Complementary effects between pairs of alleles in the same series appear to be quite common in cotton, and these and the extremely interesting modifier situations offer great possibilities in the study of dominance and gene interactions.

The bearing of theoretical studies on practical breeding problems is increasing in importance. The demonstration in hybrids of *G. anomalum* and Asiatic species that lint genes are of the same kind in

both adds weight to the advice given from this Department that interspecies hybridisation should be avoided unless it is necessary to transfer one or two otherwise unobtainable characters from one species to another. It is expected that further work on species hybrids will disclose limits to the possibility of such transference. In particular, it is likely that certain types of disease and pest resistance are dependent on the whole genotype of the wild species carrying them.

The possibilities of inter-species hybridisation and synthesis of new stable genoms have been greatly increased by the use of colchicine. The value of such new types is a matter for further investigation.

PHYSIOLOGICAL DEPARTMENT

OUTLINE REPORT ON WORK DONE DURING 1940.

BY

T. G. MASON and E. PHILLIS.

Protoplasm.

A paper on the extraction of sap from leaves by means of low pressures has been completed and presented for publication. In this paper it is shown that sap can be separated from living protoplasm as a result of prolonged exposure to pressures too low to extract vacuolar sap. This separation occurs as a result of breakdown of the protoplasm. Further work has shown that the ease with which this breakdown occurs depends on the degree of hydration as well as on age, mineral supply, etc. Sudden changes in humidity have a marked effect. It is thought that the ease with which this breakdown occurs must be related to protoplasmic structure and consequently may serve as a guide to health and resistance to pests and diseases.

Another approach to the problem of health lies in a direct attempt to unravel the primary factors on which cell hydration depends, for cell hydration appears to be of fundamental importance in determining the attacks of certain types of insects. This work is being carried out by use of discs cut from leaves. It has been found that these discs may

live for weeks floating on mineral solutions and that they may increase in fresh weight (and dry weight) by many times their initial values. At present it is only possible to say that the hydration of these isolated discs seems to depend mainly on the increase in osmotic pressure resulting from the accumulation of electrolytes by the protoplasm. Succulence due to chlorides and nitrates can readily be reproduced by this method. The increase in fresh weight is mainly due to an increase in the volume of the protoplasm ; the volume of the vacuole remaining relatively unchanged. It has been found that the osmotic pressure of the protoplasm is related to the osmotic pressure of the solution that causes incipient plasmolysis. The disparity between the latter and the osmotic pressure of the whole cell, to which Bennet-Clark has drawn attention, appears to be largely due to the fact that the osmotic pressure of the vacuole is much less than that of the protoplasm. As yet, in these discs, no direct influence of metabolism on cell hydration has been detected, while the part played by the proteins and other colloids is still obscure.

The disc method promises to be of use in making observations directly on the effect of mineral nutrition on the behaviour of certain insects. It may also help to throw light on the highly succulent foliage of cotton that occurs in certain countries and on the cause of certain failure diseases of which the Tirak of the Punjab is one example. Work on cell hydration is also being carried out on leaves attached to the plant. There are indications of the presence of a growth hormone that ascends the stem and affects the growth and hydration of the leaf.

Mineral Nutrition.

We have continued our search for a method which will help in interpreting and guiding manurial experiments. Certain features of this work were commented on in last year's report. The leaf disc method has brought to light a very interesting fact which may prove of assistance in the diagnosis of potassium starvation. It has been found that leaves from potassium-starved plants are very sensitive to injury from nitrogen and that leaves taken from plants grown with an adequate supply of potassium are highly resistant. It has also been noticed that the presence of potassium, but not apparently of other bases except possibly rubidium, in the external solution on which the discs are floating, protects a leaf taken from a potassium-starved plant against this form of injury. It has also been noticed that a reduction in leaf area leads in the case of potassium-starved plants to a very marked reduction in sugar concentration in the remaining leaves, while

in plants well supplied with potassium a reduction in leaf area leads to no change in sugar concentration.

Photoperiodism.

The effect of potassium supply and length of day on growth has been examined. Cotton plants exposed to a long day have of course a higher net assimilation rate than those grown under a short day. They have also a higher net export rate from the leaf. This increased rate of export results from an increase in the steepness of the effective sugar gradient between the leaf and the rest of the plant. Increasing the supply of potassium has the same final effect as increasing the length of the day, but in this case the increases in assimilation and in export are due to real increases in photosynthetic activity and in export; both, it is suggested, are due to changes in the rates at which materials (carbon dioxide and sugar respectively) diffuse through protoplasm. The response to changes in potassium supply is only a little greater under a long than under a short day. Leaf hydration is increased by potassium starvation under a long day, while the reverse obtains under a very short day.

Seeds.

Work on the storage of seed continues. The indications to date are that for *prolonged* storage seeds should be kept under very dry conditions (*e.g.*, over sulphuric acid). Seeds kept under these conditions show some loss of viability, when germinated in the usual manner, but if they are conditioned for about one month at 50 per cent. humidity before germinating, viability is restored.

Treating old seeds with vitamin B_1 has been claimed to increase viability. This claim we have not been able to confirm in the case of cotton.

Transport.

A number of papers on various aspects of the problem of transport have been completed and submitted for publication. One of these consists of a review of recent literature and has been submitted for publication to the American Journal, *Plant Physiology*.

Selenium.

An acre of land was selenized with sodium selenate and was found to be almost free of insect pests. The problem of finding a cheap source of selenium has not yet been solved.

COTTON EXPERIMENT STATION, ST. VINCENT.

PROGRESS REPORT FOR THE SEASON 1939-40

AND

PROGRAMME OF EXPERIMENTS FOR THE SEASON 1940-41

BY

H. L. MANNING.

Introduction.

Local differences in climate were greater this season than in any of the past three. The main reason for this appears to be spasmodic heavy rainfall in certain areas, with the occurrence of the most damaging falls during the period of boll formation. These infrequent wet spells were followed by dry periods which caused shedding and desiccation of young bolls. Yield figures for certain windward areas were quite good, while those for the Kingstown and some of the leeward areas were very poor. In addition, the Kingstown district suffered severely from an early local attack of pink bollworm. One small area was attacked by the cotton leaf worm.

The island's area under cotton amounted to 5,486 acres, of which 2,971 acres were peasant cultivation. The total yield of 616,240 lb. of white lint thus gave an average of 112 lb. per acre. The island's multiplication area of 100 acres at Diamond Estate produced 25,241 lb. of lint. It is estimated that 70,000 lb. of seed will be available for planting next season.

At the Experiment Station the lack of suitable drainage facilities during the growing period caused evident water-logging. The results of this become apparent on examination of the statistical analyses. On this station it is usual to find the fertility increasing down any gradual slope. It was observed, in all experiments on these slopes, that the usual fertility gradient was reversed. Since the fertilizer applications were uniform all over the station, this comparative reduction of yields is ascribed to water-logging. The pink bollworm infestation, causing in some strains as much as 30% stained seed cotton, necessitated early destruction of the plants so that any data on length of cropping season were rendered valueless. This was unfortunate, for in the Main Breeding Trial, in which comparisons were to be made between V.135 and VH strains, differing in bolling, time of maturity and boll weight, selection was consequently difficult. It is hoped that pink bollworm infestation can be reduced in future seasons by improved ginnery sanitation.

Genetics and Breeding.

The Main Breeding Trial.

Introduction.—This annual experiment maintains and improves the V.135 strain. During the past season ten selected V.135 progenies provided the basic material. In addition, it was decided to include some new material, thereby increasing the size of the experiment. Full details of the VH hybrids (V.135×Montserrat Sea Island) were given in the last Annual Report. It was thought that selection of this material had progressed to the point where comparison of eight VH progenies with V.135 was necessary. Two of the original progenies from P.16 (the 1928 graft of V.135) were also included, namely, P.16–4 and P.16–10.

Lay-out.—The familiar replicated progeny row technique of Hutchinson and Panse was adopted, using complete randomization of 20 progenies in 10 blocks. With 5 plants per plot there was thus a total of 1,000 plants in the experiment.

Material.—The 1938 families which provided the 1939 progenies are given below. The two VC's are re-selections made in a commercial field at Brighton Estate. Both plants gave high lint indices when grown in the Type Collection last season. The progeny Ba.1–20–21 was an outstanding plant in an otherwise poor row of the Type Collection; it is derived from the same family as V(39)10. It is to be noted that these three families were not grown in the Main Breeding Trial last season, so that the precise effect of environment on seed cotton characters was not known.

Strain.	1938 *Parent.*	*Selected for*	*No. of Plants Selected.*	1939 *Progenies.*
V.135	V(38)1 ...	Lint Length—Direct descendant of V.46–3 (V.135) from 1931	1	V(39)10
	V(38)3 ...	Lint Length, Lint Index and Seed Weight	2	V(39)8 & V(39)14
	V(38)4 ...	Lint Index and Ginning %	2	V(39)1 & V(39)11
	V(38)8 ...	Lint Index, Total Lint and Bolling... ...	2	V(39)16 & V(39)20
	VC 19–46 ...	Lint Index	1	V(39)3
	VC 7–59 ...	Lint Index and Total Lint	1	V(39) 4
	Ba 1–20–21	Lint Index and Total Lint—Type Collection	1	V(39)18
VH	VH(38)8 ...	Lint Length, Total Lint and Good Parental Spinning Test	2	VH(39)2 & VH(39)7
	VH(38)9 ...	Lint Length, Lint Index, Total Lint, Boll Loculi and Monopodia	4	VH(39)5, VH(39)12, VH(39)13 & VH(39)19
	VH(38)10 ...	Boll Loculi and Total Lint	2	VH(39)15 & VH(39)17
P.16	P.16(38)4 ...	Comparison—1928 Graft of V. 135... ...	1	P(39)6
	P.16(38)10...	Comparison—1928 Graft of V.135	1	P(39)9

Analytical Results.—Examination of the summary appended (Table I) shows that the main strain differences were clear cut in the following characters : number of monopodial branches, boll loculi value, lint per boll, seeds per boll, lint index and ginning percentage. The influence of the Montserrat variety in reducing monopodial development and raising boll loculi value, lint per boll, lint index and ginning percentage is clearly shown in the VH strains.

TABLE I.

Strain.	*Progeny.*	*Mono-podial Branches —trans.*	*Mean Boll Loculi.*	*Bolls per Plant.*	*Lint per Boll.*	*Seeds per Boll.*	*Lint Index.*	*Ginning %*	*Lint Length.*
V(30)46 ...	V(39)10	1·851	3·077	32·3	·520	13·90	3·753	23·61	60·30
	V(39)18	1·846	3·058	29·0	·523	13·99	3·740	24·47	59·83
V(37)11 ...	V(39) 1	1·890	3·070	27·4	·533	13·35	3·974	24·72	59·82
	V(39) 8	2·007	3·070	29·0	·543	13·74	3·951	24·69	60·29
	V(39)11	1·952	3·096	30·6	·537	13·94	3·898	24·47	59·50
	V(39)14	1·959	3·084	26·1	·525	13·18	3·956	24·58	59·87
	V(39)16	1·915	3·076	31·5	·542	13·91	3·848	24·52	59·81
	V(39)20	1·873	3·068	28·8	·524	13·32	3·948	24·56	60·01
V.135 Commercial Re-selections	V(39) 3	1·987	3·072	33·6	·519	13·67	3·814	24·40	59·91
	V(39) 4	1·926	3·076	30·5	·526	13·41	3·842	23·82	60·28
VH(38) 8 ...	VH(39) 2	1·719	3·316	31·3	·583	12·88	4·542	27·19	58·92
	VH(39) 7	1·654	3·380	29·2	·599	13·16	4·457	27·07	59·13
VH(38) 9 ...	VH(39) 5	1·874	3·411	28·9	·645	12·89	4·820	27·47	59·09
	VH(39)12	1·775	3·382	25·6	·604	12·69	4·763	27·18	59·49
	VH(39)13	1·782	3·400	26·7	·621	13·04	4·738	27·78	58·88
	VH(39)19	1·800	3·412	30·4	·605	13·12	4·614	27·19	58·93
VH(38)10 ...	VH(39)15	1·593	3·408	25·4	·599	12·91	4·638	26·90	58·56
	VH(39)17	1·758	3·406	32·1	·616	13·03	4·685	27·42	58·87

Significant differences between progenies were recorded for all characters except total seed cotton and total lint.

In the analysis of variance for germination what has been suspected for some time is clearly shown—in general the VH hybrids are inferior to V.135 for this character, at this station. Earliness, as indicated by node number and number of days to first flower, corroborated the findings of the past season in that P.16 is earlier than most V.135 progenies. Within V.135 it is interesting to note that V(39)10 is derived from V(38)1 which was also earliest in 1938. In general, the VH progenies show only small differences from the V.135 progenies. In previous years the plant height of the VH progenies has on the whole been shorter than V.135, but some extremely vigorous progenies, namely, VH(39)2 and VH(39)7, have been selected which were as tall. Also, some of the 1939 VH progenies have as many monopodial branches as V.135. The VH progenies were, as expected, all significantly better than V.135 in boll weight and associated values, for which strong selection has been exercised.

Bolling figures were in general disappointing. With its high mean number of monopodial branches, V.135 is potentially a high-boller,

but it requires a longer season to realise its yield than do low-bolling, large-bolled types such as Montserrat Sea Island and VH. Normally the necessary time is available in St. Vincent, but the season under review was cut short by a severe local attack of pink bollworm, and the differences in bolling recorded between V.135 and VH are therefore smaller than they would otherwise have been.

Lint length analyses indicate the superiority of the V.135. It is satisfactory to note that at least three of the VH strains have acquired superfine length and, assuming that hair tests show that superfine quality has also been attained, it is clear that these VH strains will provide valuable material in the subsequent Main Breeding Trials.

Discussion of Results.—The V.135 material comprises two strains and two selections from a commercial field. The two strains consist of (*a*) descendants of V(30)46 and (*b*) descendants of V(37)11. The former is the standard V.135 strain selected continuously for lint length, and the latter is descended from a high-ginning selection from the 1936 multiplication plot, selected thereafter for high lint index. Lint indices and lint lengths are given in Table I. It is clear that selection has resulted in a marked improvement in lint index with no appreciable sacrifice in lint length.

Pending the examination of the hair characters of V.46 and V.11 it was considered inadvisable to select any further for high lint index, in case the hair weight is carried beyond the limit for superfine cottons. Selections were therefore based on the yield components : seeds per boll, seed weight, lint index, lint per boll, bolling, and on lint length. With these characters in view, the V.135 progenies from which the most useful material can be obtained are V(39)3, V(39)4, V(39)8, V(39)10, V(39)11, and V(39)16. Selections from a commercial field will thus be included in the next trial alongside progenies of the two main strains V.46 and V.11.

The VH strains have continued to show promise, and many of the recombinations of characters for which the cross was made have been established. The VH(38)8 descendants, VH(39)2 and VH(39)7, clearly resemble V.135 in many respects but, in the all-important pyramidal habit (number of monopodial branches), they resemble the Montserrat type. The VH(38)9 series (VH(39)5, VH(39)12, VH(39)13 and VH(39)19) is more nearly similar to the ideal plant, having the pyramidal habit of V.135 in addition to the desirable boll weight characters and high boll loculi value of the Montserrat strain. The most outstanding plant, however, occurred in the high-yielding VH(38)10 derivative, VH(39)17, which was thought to resemble more closely the Montserrat type. This plant has the excellent height,

high bolling, large number of monopodia and lint length of V.135 in addition to the boll loculi value, seed weight and lint index of the Montserrat parent.

All the VH material now under test has the lint length of V.135. If it is to compete with V.135 in commercial culture it must also have superfine hair weight and spinning value. Material has been sent for testing, but the data are not yet available.

The VH strains from which material will be selected are as follows :— VH(39)2, VH(39)5, VH(39)12 and VH(39)17.

In addition to the VH and V.135 strains, four Barbados strains will be included to make a total of 20 sub-strains in the 1940–41 Main Breeding Trial.

Small Bulks Trial.

The sequence of this trial, which follows the Main Breeding Trial of the previous season, provides confirmation of these single-plant results. This season the ten V.135 progenies of 1938 were bulked and planted out in 1/160 of an acre plots. There were 10 replications of each strain. Of the ten bulks, Nos. 1 and 2 belonged to strain V(30)46, Nos. 3–8 to strain V(37)11, and Nos. 9 and 10 to V(37)12.

No significant differences were recorded for germination, total clean seed cotton or total clean lint. Analyses of variance for the characters flowering, lint length, ginning percentage, seed weight and lint index have all, however, indicated significant differences. Strains V(37)11 and V(37)12 were both selected primarily for ginning percentage and lint index, whereas V(30)46 represents the main breeding line, in which the chief emphasis was laid on staple length. Data for these characters are summarised in Table II, and it will be seen that V(37)11 and V(37)12 were markedly superior to V(30)46 in lint index and ginning percentage and were not inferior in staple length.

TABLE II.

Strain No. ...	V(30)46		V(37)11						V(37)12	
Bulk No. ...	VB1	VB2	VB3	VB4	VB5	VB6	VB7	VB8	VB9	VB10
Ginning % ...	26·2	26·0	26·6	26·8	26·9	27·0	26·4	26·8	26·7	26·9
Lint Index ...	4·01	4·13	4·19	4·28	4·30	4·29	4·11	4·23	4·25	4·23
Lint Length ...	60·5	60·2	60·6	59·7	60·3	60·1	60·0	59·9	60·0	59·8

There were also small but significant differences in staple length and lint index between progenies in V(37)11, suggesting that further improvement by selection is possible. The data from this trial therefore support those from the Main Breeding and they are also in substantial agreement with those of the Main Breeding Trial of the previous year. Correlations were calculated between the 1938–39

Main Breeding Trial results and the 1939–40 Small Bulks data, and were as follows :—

Ginning %	r = +0·06	P = 0·05
Lint Index	r = +0·57	P = 0·10
Lint Length	r = +0·71	P = 0·02

The family VB(39)3 is rather interesting. In the Main Breeding Trial and the Small Bulks Trial it was the best all round family, excelling in lint length and lint index.

Lint samples from the three strains V(30)46, V(37)11 and V(37)12 were sent from the 1938–39 Small Bulks Trial for examination at the Shirley Institute. Hair Weight and Standard Hair Weight data kindly supplied by the Shirley Institute are given below :—

Strain.	*Hair Weight.*	*Standard Hair Weight.*
V(30)46	96·5	116
V(37)11	98·5	117
V(37)12	97·0	115

It is clear that the increase in lint index has been achieved without sacrifice of fineness.

This experiment will be continued next season, when the material will consist of eight VH and two V.135 strains from this season's Main Breeding Trial.

Seed Size Experiment.

Multiplication seed of V(38)3 was sorted into three size groups—small, with a mean weight of 9·95 milligrammes per seed ; medium, 11·90 milligrammes per seed ; and large, 14·33 milligrammes per seed. An experiment was laid out with eight replications of these three seed sizes, and growth, development and fruiting were studied to see whether differences in seed size were reflected in the subsequent plants. Observation and analyses of germination, earliness to flower, total seed cotton, total lint, seed weight, lint index and ginning percentage showed no significant differences between seed size classes. While size alone appears to be of little importance, it is possible that where seedlings from seeds of different sizes are in direct competition, a large seed may have an advantage. Only elaborate tests could decide the matter.

Yield Test of VH Hybrids against their Parental Strains.

Introduction.—This experiment was designed to obtain comparative yield data against the standard V.135 under a range of environmental conditions. The lay-out consisted of a pair of blocks at each of four localities, Experiment Station, Camden Park, Union, and Orange Hill, and the analyses of variance were carried out in the form of a serial experiment. The variability was divided into portions due to

differences between blocks, localities, strains, localities×strains (interaction) and error. Individual plot size was 1/160 of an acre.

The four localities represented the main cotton-growing soil types of the island, and the season was such that the differences between them was accentuated by differences in amount and distribution of rainfall. On the Experiment Station the two blocks occupied a fertile field which almost always gives a high yield of V.135. At Camden Park the soil is valley alluvium, as at the Experiment Station, but rather heavy, and its cropping capacity is much affected by season. At Orange Hill the soil is recent volcanic ash, and the rainfall was good and well distributed, giving excellent growth. The Union plot was chosen to represent poor, eroded hillsides.

Discussion of Results.—In total seed cotton and total lint there were significant interactions between locality and strain.

The experiment was a preliminary one and, with only two blocks in each locality, little reliance can be placed on the details of the statistical analyses. Yield data are summarized in Table III (below), however, and certain general conlcusions can be drawn.

TABLE III.

MEAN OF TWO BLOCKS AT EACH LOCALITY FOR EACH OF THE FIVE STRAINS.

TOTAL SEED COTTON, IN GRAMMES.

Strain.	*Experiment Station.*	*Camden Park.*	*Union.*	*Orange Hill.*	*Mean of all Localities.*
MSI	1,633	2,735	1,208	3,188	2,189
VH 8	1,710	2,893	1,540	4,283	2,606
VH 9	1,520	2,602	1,330	5,245	2,674
VH10	1,630	3,180	1,405	3,978	2,548
V 135	2.973	3,385	1,175	4,453	2,996

TOTAL CLEAN LINT, IN GRAMMES.

MSI	548	810	413	1,050	705
VH 8	505	865	458	1,228	764
VH 9	455	685	393	1,528	765
VH10	485	890	423	1,140	734
V 135	760	715	310	1,145	733

At the Experiment Station V.135 gave nearly twice as much seed cotton as the other strains. At Camden Park it gave a little more than the others and at Orange Hill about the same. Under the poor conditions at Union, however, it was outyielded by every other strain. At the Experiment Station Montserrat Sea Island gave about the same seed cotton yield as the VH's, but at the other three places it was considerably outyielded by them. In yield of lint the position of V.135 was brought down by its low ginning percentage, so that it was outyielded by the VH's at all places except the Experiment Station. The relative position of M.S.I. is much the same as in seed cotton. The experiment indicates that V.135 is unlikely to be beaten by VH

strains under the best conditions of soil and season, but the VH's appear to withstand unfavourable conditions better.

The VH hybrids have been so encouraging that, provided that spinning test results are favourable, a further trial with VH9 and VH10 against V.135 is to be carried out at two localities. A more comprehensive lay-out, which will include manurial treatments, will be adopted in the season 1940–41.

A Randomized Trial of Eight Sea Island Strains.

Introduction.—The object of this experiment was primarily to test the behaviour, under St. Vincent conditions, of the main Sea Island varieties. At the same time a very promising VH strain and P.16 were included for comparison with V.135.

Besides these three, the following varieties were included in the experiment :—Barbados (BSI). A superfine with high bolling and of pyramidal habit. Montserrat (MSI). An ordinary with low bolling and of sympodial habit. Nevis (NSI). A fine cotton with high bolling. These represent the commercial cottons.

Two ordinary Sea Islands, BD and Sea Island White (SIW), isolated in St. Vincent were included also. The two latter are low bollers with the sympodial habit, which give comparatively high yields by virtue of their good boll weight characters.

Lay-Out.—There were eight replications of each of eight strains, plot size being $40' \times 4'$. These single-row plots were all adjacent, thus making the block size $32' \times 40'$. Two plants per hole at 2′ spacing within the plot gave a plot population of 40 plants.

Analytical Results.—Germination was excellent, by contrast with that obtained in the 1937–38 trial, and there were no significant differences between varieties. It is suggested that the significant inferiority of BSI in this character in the last trial may have been due to poor seed since, but for this transposition, the general order of the strains is the same. Earliness was assessed by counting the plants which had flowered at 70 days. In general, this should have followed the order shown in the analysis for node number. The notable exceptions to this were NSI, P.16 and BSI. In the first strain it was noticed during field observations that nearly all the flower buds on the lower main axis sympodia shed. To a lesser extent this is also true of P.16 and BSI, so that the early formation of the first fruiting branch in these strains has been counterbalanced by shedding losses. It is clear from both trials that MSI, on account of its high node number, is the latest of these strains to flower. VH resembles its MSI parent in node number. Both of them, however, appear to have a shorter period of boll development as picking commences rather earlier than

in the other strains—except SIW. Number of monopodia provided an interesting comparison for the main Sea Island strains, with V.135 having the greatest number and MSI the fewest. Owing to the skew distribution of this character the addition of 0·5 and square root transformation method of analysis of variance was carried out (Cochran 1938). There were significant differences in bolling in spite of unfavourable growth conditions. The plants with a predominantly sympodial habit should have theoretically, and have in practice, fewer bolls. The varieties with a pyramidal habit and high monopodial development did not have the opportunity for full expression—because the dry spell in January inhibited the development of many of the bolls on the monopodia. As a result of the bolling conditions the seed cotton per plot showed no significant differences since, in general, the superfine strains with high bolling usually have smaller bolls. Owing to the better ginning out-turn of the shorter staple strains, the differences in lint per plot were accentuated and significant differences were obtained. In the characters lint index, lint per boll, seed cotton per boll, seed weight, lint length and ginning percentage, all of which are straightforward analyses of variance, the expected substantiation of the previous trial was obtained.

Conclusions.—It is quite clear that in normal seasons the high yield of seed cotton per acre of certain superfine strains is due to their high bolling capacity. The close correlation between bolling and yield of these strains illustrates the importance of the enormous potential bolling of their monopodials under suitable conditions of maturity. This is particularly evident in V.135. At the same time this monopodial habit is usually associated with low seed cotton per boll. In the present trial the notable exception to this is VH. Besides combining a pyramidal habit with high seed cotton per boll, it has a high ginning out-turn, so that in yield of lint it is the outstanding superfine strain. The ordinary Sea Island strains are comparatively poor bollers—and even among these SIW is usually the lowest. Consequently the high position of this strain in the bolling figures requires some explanation. This is entirely due to a single plot in which the yield figures are almost double those of the other blocks. The use of Yates' Missing Plot technique reduces the bolling mean from 28·1 to 25·0, which is one before last—the expected position. Applying a similar correction for the abnormal plot to the lint yield figures only reduces the yield of SIW to that of MSI, which was the second highest yielder in the trial.

In the previous trial NSI was considered as a possible superfine substitute for V.135. It is apparent in the present trial, on consideration of the figures lint index, seed weight and ginning percentage, that this

last high figure has only been obtained as a result of the low seed weight and that, in the present trial at least, the strain's only recommendation is its high number of seeds per boll. A further disadvantage is its very creamy colour.

Among the shorter staple strains MSI is outstanding, and though SIW has about the same lint per plot this latter stands condemned by reason of its short, coarse staple.

BSI, in its present state, and P.16 appear to be two strains for which there is little future. These conclusions with regard to the former were established in the 1937–38 trial and are fully substantiated in this.

During the 1940–41 season another Variety Trial will be carried out, using the types V.135, MSI, BSI, NSI, BD, SIW and two VH strains.

Barbados Sea Island Breeding Material.

The seed of this material was received late in the season and germination was poor. It consisted of two families, P.170–2 and P.170–4, of the Barbados Sea Island strain S(27)6, and three progeny bulks (B.1, B.2 and B.3) of P.170–2 and two (B.4 and B.5) of P.170–4. Twenty plants each were grown of P.170–2 and P.170–4, and about 100 plants of each of the progeny bulks.

Field observations indicated that the Barbados bulks are all prolific bollers, but unfortunately any advantage thus gained is more than offset by the extremely low boll weight characters. In the family P.170–4 the bolls were " marble-like " in size, and it was suspected and subsequently shown that the ginning percentage was extremely low (actually 23·1). Seed cotton characters are summarised below :—

Bulk.	*Lint Length.*	*Ginning %.*	*Lint Index.*	*Seed Weight.*
P.170–2	57·6	25·2	3·79	11·3
B.1	58·1	25·7	3·89	11·3
B.2	58·1	25·9	4·10	11·7
B.3	56·1	27·0	3·54	9·6
P.170–4	59·2	23·1	3·30	11·0
B.4	58·5	23·7	3·27	10·1
B.5	58·4	24·2	3·35	10·5

Examination of frequency arrays revealed exceptional variability within and between the seven bulks. Taking lint length as one of the most important factors influencing lint quality, it is clear that the strain B.3 can be eliminated from further trials, in spite of its high ginning percentage. It will be seen that the latter high mean value is a direct result of poor seed weight. Similarly B.4 can be eliminated on account of its poor seed weight.

Among the remaining strains the best is B.2, with good seed weight, lint index and ginning percentage. Although not one of the longest, its lint length is not below the accepted mean value for superfine strains, and it appears to have some possibilities.

It is proposed to include four selections in the Main Breeding Trial of 1940–41. This direct comparison with V.135 and the VH hybrids should provide some useful information on the comparative behaviour of the Barbados Sea Island strain.

Type Collection.

The type collection which is confined to *Barbadense* cottons was this season augmented with the American strains Bleak Hall, Seabrook and Westberry. Besides these, Puerto Rico, Sind and Fiji Sea Island cottons were added. It is of interest to note that the strains Bleak Hall and Seabrook resemble respectively the V.135 and Montserrat Sea Islands. It can be seen from the summary that the main points of difference are—for Bleak Hall a low boll loculi value (3·1), fair number of monopodial branches (about 2), and good lint length (59 mm.). In Seabrook the boll loculi value is high (3·3) and monopodial branching low (0·8), while it has a lint length of only 52 mm. The Westberry strain is extermely short and more nearly resembles S.I.W. than any other strain. The Sind and Puerto Rico strains appeared to be of the ordinary Montserrat Sea Island type as distinct from the superfine V.135. Field data on the Fiji variety were insufficient to determine its parental type.

During the season 1940–41 it is proposed to purify further and standardize these strains, all of which indicated great variability. Only Sea Island varieties of possible commercial value will be grown in the type collection in future. There are at present 24 of these. At the same time, to maintain variability within main strain types for selection purposes, a series of variable bulks (75 plants) are to be maintained of the strains AN, BD, S.I.W., O.S.I. (St. Vincent strains), B.S.I., N.S.I., St. Kitts, Montserrat, Bleak Hall, Seabrook and Westberry.

Genetic Experiments.

Semi-Sterile Mutant of V.135.

The four plants to which reference was made in the Annual Report last season provided four families this season. It will be remembered that the selections referred to were heterozygous.

The ratio of Normal to Heterozygous or Mutant plants for each of the four families was respectively 33 : 20, 32 : 25, 32 : 29 and 31 : 25. Unfortunately in making seed counts per boll the pink bollworm infestation was such as to render some of these counts valueless.

Plants known to be normal gave mean values of less than 12 for this character. Since the hypothesis under test involved the supposition that a large proportion of certain zygotes failed to develop into mature seeds, the lack of reliable seed counts is very unfortunate.

Besides the heterozygous plants, ten families from ten normal plants of the same strain were grown to test normality. In these ten families of sixty plants each there were, as far as could be determined from field observations, no heterozygous or mutant plants.

It has been decided to transfer the entire experiment to the Cotton Research Station, Trinidad.

The Genetics of Fuzzed V.135.

(*a*) Four F_3 families of Tufted × Fuzzed V.135 were grown in continuation of the experiment from the past season. Results, which follow, indicate a single gene difference with tuft dominant.

Family.	*FUZZY, Grade 6–8.*	*TUFTED, Grade 3 and Below.*	*Remarks.*
1	7	23	Het. parent plant
2	0	30	Homo. ,, ,,
3	8	22	Het. ,, ,,
4	7	23	Het. ,, ,,
Total Het. Families	22	68	90
Expected 1 : 3	22·5	67·5	90·0

(*b*) Two F_2 families of Fuzz × Naked were grown this season.

The crosses Tuft × Fuzz and Tuft × Naked have shown that both naked and fuzz differ from tufted in a single gene. Tuft was a simple dominant in both cases. There are therefore two possibilities : fuzzy and naked may be independent of each other, or they may be allelomorphic. If they are independent, the segregation should be 9 Tufted : 3 Fuzz : 4 Naked (assuming the double recessive to be naked). If they are allelomorphic, the segregation should be 2 Tufted : 1 Fuzz : 1 Naked.

The actual segregation of the F_2 families was 19 Tufted : 9 Fuzz : 12 Naked. Large families are required to test the hypothesis critically, as the proportions expected on the two hypotheses differ very little.

Acknowledgments.

To the planters who co-operated to make the Yield Test possible the writer wishes to express his thanks. Opportunity is also taken to thank the Agricultural Department for continued co-operation. To Mr. Stephens, of the Cotton Research Station, Trinidad, he is indebted for assistance with the analysis of the genetics section.

Finally the writer gratefully acknowledges the valuable help and suggestions of the Geneticist, Cotton Research Station, Trinidad.

EXTENSION OF PROGRAMME.

Other experiments to be included in the 1940–41 Programme are as follows :—

Uniformity Trial.

A comprehensive survey of single-plant yields from 2,000 plants to determine the most suitable plot size and shape which will give a reasonably low standard error per cent.

Manurial Experiment.

To determine the optimum time of application of two levels each of nitrogen and potash.

(Included by courtesy of the Fiji Government.)

FIJI.

GENERAL EXPERIMENTAL STATION, SIGATOKA, COTTON PROGRESS REPORT FOR THE SEASON 1939-40.

BY

H. R. SURRIDGE.

The season under review was dry and repeated sowings had to be made to obtain a uniform stand. Weather during the growing period was satisfactory and plants made normal growth.

Jassid appeared in January in a plot of Backcross 172 cotton, which had been ratooned for maintenance of the strain. From this plot the pest migrated to others and caused considerable damage. The first crop was shed in all cottons and only a portion of the second crop was harvested.

In view of the increase of jassid at the Station during the past two or three seasons, the Director of Agriculture decided that a close season of two months should be observed. Consequently all cotton plants were cut down and burnt by the end of August.

Meterology.

The total rainfall for the season (September, 1939, to August, 1940) was 57·83 inches, which is 14·99 inches below the normal for the past twelve years. Rain fell on 148 days which is only 1 day above the average.

Agriculture.

Exhaustion Experiment.—A long-term exhaustion experiment was commenced in which cotton, maize and sugar cane were grown in triplicate plots.

Ratooning.—In view of the Government's decision to issue only Sea Island seed to the growers during the past season, it was decided to ratoon an isolated plot of Backcross 172 to maintain the strain. Seed obtained from this plot will be distributed to growers during the coming season.

Sea Island Bulk.—A bulk crop was again grown on an isolated block and forty-five bulk selections were made.

Genetics and Breeding.

Increase Plots. –Selections 172/23/1 and 172/23/5 were again grown in increase plots of one acre each. Both show an improvement on Backcross 172 in regard to length and fineness of lint. Multiplication of Backcross 172 and Backcross 172/23/1 is being undertaken during the coming season, seed being issued to selected growers in the Sigatoka Valley. Comparative essential data for the three cottons are given hereunder :—

	Backcross 172	172/23/1	172/23/5
Lint Index	5·38	5·34	5·69
Ginning Outturn (%)	27·25	28·75	28
Mean maximum lint length	46 mm.	49 mm.	48 mm.

Progeny Rows. –Thirty-eight strains of Kidney Sea Island Third Backcross, four of Montserrat Sea Island and three of Kidney Sea Island Backcross were grown in progeny rows. Of these, three strains of Third Backcross, two of Montserrat Sea Island and one of Backcross will be retained for further progeny row tests.

Comparative data for the best strain from each cotton are given below :—

	Third Backcross 81	*Montserrat Sea Island* 10	*Backcross* 172/23/5/1
Lint Index	5·21	5·51	6·11
Ginning Outturn (%)	25·25	27·5	28
Mean maximum lint length	55 mm.	52 mm.	49 mm.

Single Plant Selections.—Twenty-two single plant selections from Third Backcross, thirteen from Montserrat Sea Island, four from Fiji Sea Island and eleven from Backcross 172/23 were made, of which twelve from Third Backcross, five from Montserrat Sea Island, two from Fiji Sea Island and nine from Backcross 172/23 have been retained for progeny row plantings.

Entomology.

Cutworm.—Some damage was done to seedlings early in the season.

Tipworm (*Earias fabia*).—Caused extensive damage to all cottons, rendering selection work difficult.

Pink Bollworm (*Platyedra gossypiella*).—Was more than usually prevalent.

Cotton Stainer (*Dysdercus insularis*).—No trace of this insect was found. Since this pest usually appears late in the season, the early close season practised this year is probably responsible for its non-appearance.

Harlequin Bug (*Tectocoris lineola*).—Was present in small numbers.

Jassid (*Empoasca sp.*).—This pest was by far the most destructive in all cottons. It appeared early and was active throughout the season. Control with sprays on a small scale will be tried next season.

Green Vegetable Bug (*Nezara viridula*).—A shield bug, green in colour, identified by the Government Entomologist as *Nezara viridula*, was found on young cotton plants early in the season. It is a sucking insect supposed to cause boll-rot. As the season advanced, however, it disappeared from cotton but was found on cowpea and tobacco crops. No boll-rot due to this insect was found.

Mycology.

Blackarm disease (*Bacterium malvacearum*).—Very little trace of this disease was found.

PROGRAMME FOR 1940-41.

(1) Twenty-eight Single Plant selections from Third Backcross, Montserrat Sea Island, Fiji Sea Island and Backcross 172 to be grown in progeny rows.

(2) Four strains from Third Backcross and Backcross 172 will again be grown in progeny rows.

(3) Bulk selections from Sea Island to be grown in increase plot.

(4) Cotton to be grown again with maize and sugar cane in exhaustion experiment.

(5) Cotton to be grown with maize, cowpea, potato, rice and sweet potato in fertility experiment.

(6) Seed of Backcross 172/23/1 to be issued to selected growers in the Sigatoka Valley for multiplication and bulk cotton.

(7) Seed of Backcross 172/23/5 to be grown for bulk and multiplication at the General Experimental Station.

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